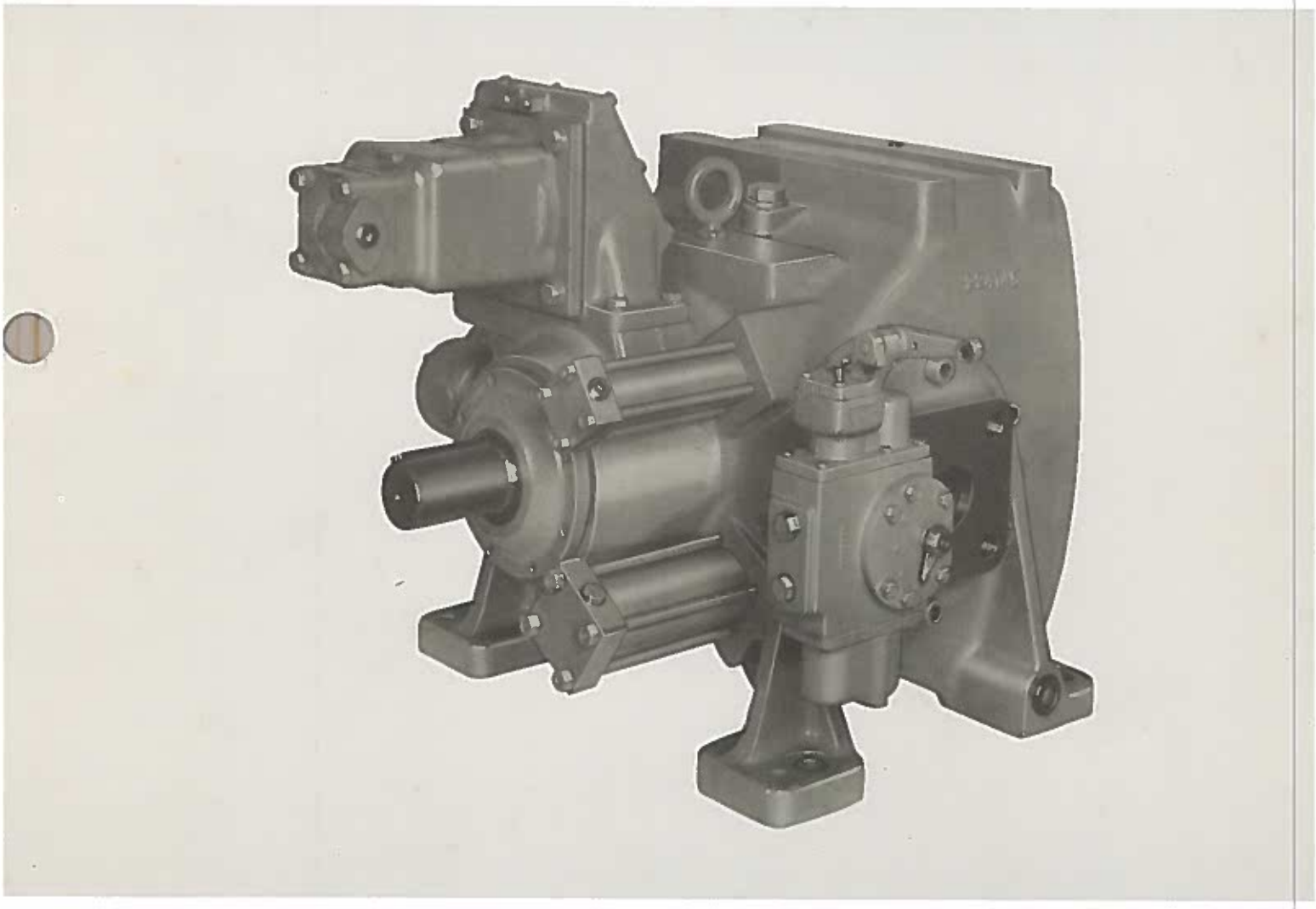
VICKERS®
A TRINOVA COMPANY

Overhaul Manual

Variable Displacement Piston Pumps & Motors

MVA120-**-**
MVA150-**-**
PVA120-**-**
PVA150-**-**

21



Vickers, Incorporated
1401 Crooks Road
Troy, Michigan 48084

Revised 2-1-77 **I-3201-S**

TABLE OF CONTENTS

	Page
OPERATIONAL CHARACTERISTICS	1
MODEL CODE BREAKDOWN	2
OPERATION	3
INSTALLATION & MAINTENANCE	4
TROUBLE SHOOTING CHART	5
OVERHAUL	6
AUXILIARY PUMP MOUNTING	7
EXPLODED VIEW OF PUMP	8
EXPLODED VIEW OF PUMP	9
INSPECTION AND REPAIR	12
AUXILIARY PUMP INSTALLATION	14
ELECTRO-HYDRAULIC CONTROL	14

OPERATING CHARACTERISTICS

TYPE ..... Axial Piston, Variable Displacement

WEIGHT ..... Approximately 1100 lbs

MOUNTING ..... Foot

OPERATING FLUID ... Petroleum Oil, 150 to 225 SSU at 100°, meeting or exceeding lubricating qualities of SAE 10W, API Classification MS

MODEL NO.	THEORETICAL MAXIMUM DISPLACEMENT CU/IN./REV.	GPM DELIVERY		DRIVE SPEED RPM		PRESSURE PSI		EFFICIENCY AT MAX. DISPLACEMENT, MAX. PSI AND RATED RPM	
		RATED	MAX.	RATED	MAX.	RATED	MAX.	VOLUMETRIC	OVERALL
PVA 120	23.71	120	180	1200	1800	3000	5000	96%	94%
PVA 150	28.96	150	150	1200	1200	2500	3000	96%	94%

MODEL NO.	DISPLACEMENT (MAXIMUM) AT ZERO PSI CU/IN./REV.	THEORETICAL TORQUE PER 100 PSI (LB.-IN.)	OPERATING SPEED RPM		PRESSURE (PSI)		OUTPUT SPEED (RPM PER GPM)
			MIN.	MAX.	RATED	MAX.	
MVA 120	23.71	378	50	1800	3000	5000	10
MVA 150	28.96	460	50	1200	2500	3000	8

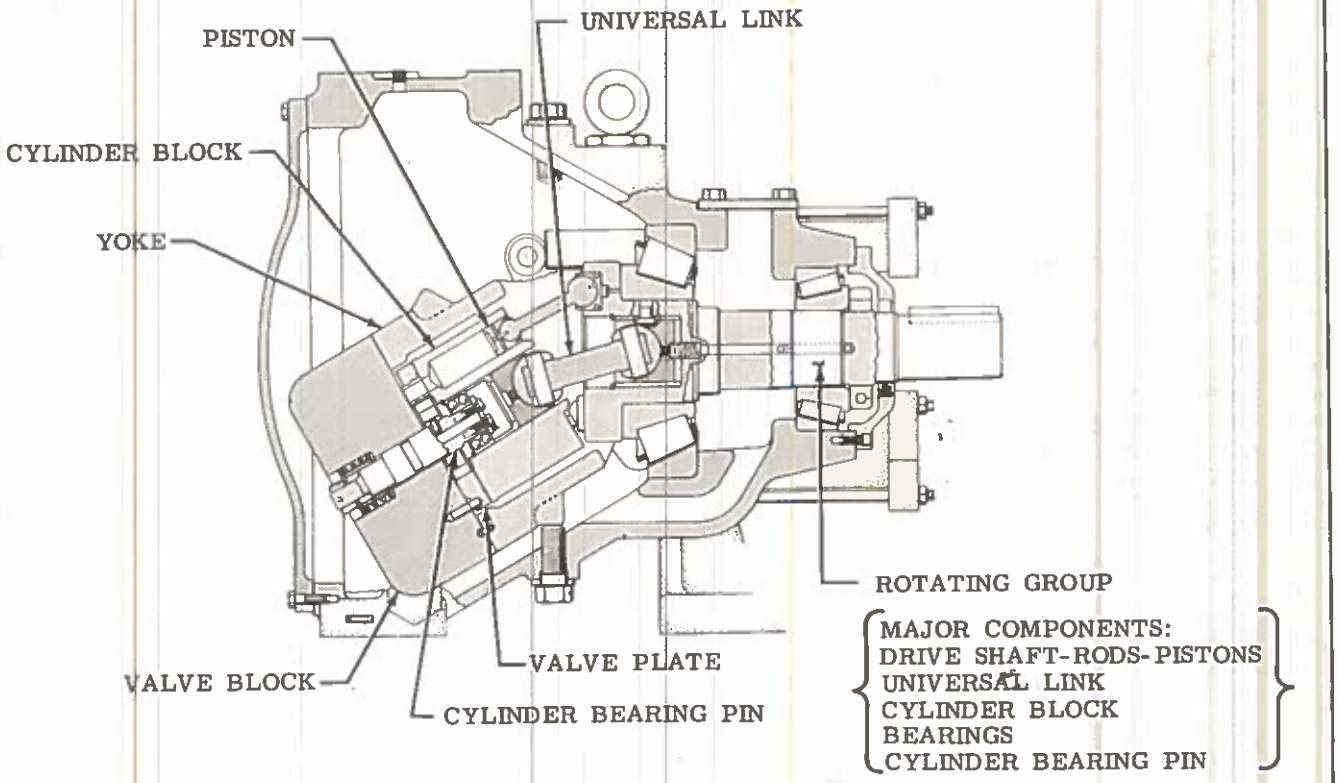
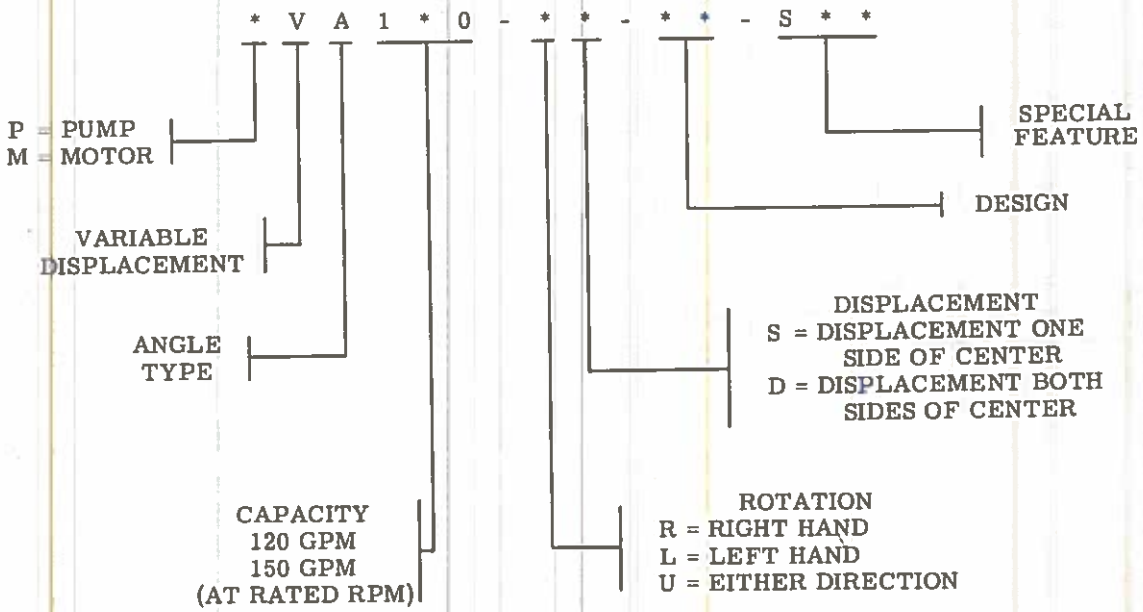


Figure 1. Sectional View of Unit Assembly

TABLE I. MODEL CODE BREAKDOWN



DESCRIPTION

This manual provides service and maintenance instructions for Vickers PVA/MVA 120 and 150 series of pumps and motors. These units are in the large size category and are capable of high displacement, high pressure operation.

All of the units, both pump and motor, are variable displacement, axial piston type. The primary subassemblies of each unit are: a rotating group, yoke and pintles, valve plate, valve block, housing, bearings and seals. (See figures 1 and 3.) Design and construction of the two series is almost identical. The 150 series greater displacement is accomplished by: larger bores in the cylinder block, larger diameter pistons and wider ports in the valve plate and valve block.

Four different yoke control systems may be used on each unit. (See Table II.) The selection depends on the system application of the unit. An auxiliary pump may be mounted on the housing and driven by a chain from the drive shaft. This pump may be used as part of the yoke control system or for other purposes.

Operating particulars for a specific unit, such as displacement, rotation---- etc., can be determined by the model number on the nameplate. The Model Code Breakdown key appears in Table I. Application data appears on the installation drawings which are listed in Table II.

TABLE II. INSTALLATION AND PARTS DRAWINGS

MODEL	INSTALLATION DRAWING	PARTS DRAWING
PVA 120 and MVA 120	SEE BELOW	I-3205-S
PVA 150 and MVA 150		I-3207-S
(WITH) ELECTRO-HYDRAULIC CONTROL	I-250443	
(WITH) HYDRO-MECHANICAL CONTROL	I-250444	I-3214-S
(WITH) PRESSURE COMPENSATOR CONTROL	I-250445	I-3210-S
(WITH) HAND WHEEL CONTROL	I-250446	

OPERATION

A. PUMP OPERATION.

During operation, a power source turns the pump drive shaft which, through the universal link, turns the cylinder block. See figures 1 and 3. The cylinder block containing the pistons is displaced from the drive shaft axis by an angle determined by the setting of the yoke. As a result, the pistons move back and forth within the bores during rotation. During the time that a piston is being drawn back, hydraulic fluid flows into the cylinder bore through the valve block and valve plate. As the cylinder bore is rotated over the valve plate outlet, the piston is being forced into the bore thereby forcing the fluid out. The complete path for the fluid is, in through the pintle, yoke, valve block, valve plate, cylinder bore and then out through another set of passages in the valve plate, valve block, yoke, and opposite pintle.

The angle between the drive shaft and cylinder block axis determines the length of travel of the pistons within the bores. This angle therefore affects the delivery rate or displacement of the pump. Since this angle is variable by positioning the yoke, the pumps in this series are called variable delivery pumps.

B. MOTOR OPERATION.

Motor operation is essentially the reverse of pump operation. A motor converts hydraulic pressure into a rotary mechanical motion.

In operation, the inlet fluid is forced into the cylinder bores which are open to the inlet port. The remaining cylinder bores are either open to the outlet port or blocked by the valve plate. The hydraulic pressure cannot push the piston back in the bore because of the mechanical link to the drive shaft. As a result, a force component determined by the angle between the cylinder block and drive shaft axis causes a rotary motion of the cylinder block. The motion is transmitted to the motor shaft by the universal link. The fluid discharges into the reservoir or system as the bores move over the valve outlet port.

Motor speed and torque are affected by the input flow rate and pressure, and also by the angle between the cylinder block and drive shaft axis. Since the angle is variable by yoke movement in this series, an additional control of speed and torque is available.

INSTALLATION

A. GENERAL.

Specific details concerning items such as mounting, circuit design, performance characteristics, special applications---etc., are available from the applicable installation drawing. (See Table II.) Only some of the considerations involved with the installation of a replacement or overhauled unit in an existing circuit appear below.

B. ALIGNMENT.

Check the alignment of the pump with the drive source or motor with the load. Misalignment will cause noise, vibration, and excessive bearing wear.

C. FLUID.

The choice of hydraulic fluid is one of the most important considerations. The useful life of your unit is directly related to the type of fluid used. Use a clean petroleum oil of viscosity range 150 to 225 SSU at 100°F and meeting or exceeding the lubricating qualities of SAE 10W, API service classification MS.

D. STARTING AND PRIMING.

In addition to being the work medium, the hydraulic fluid must also provide lubrication for the components in the system. Because of this, all air must be removed from the system to provide maximum efficiency and wear life. Oil circulation through the housing is also recommended for the PVA/MVA 120 and 150 series units. Refer to the installation drawings for the specifications.

Observe the following during start-up:

(1) Before starting the unit, fill the housing with fluid.

(2) Check the fluid level in the reservoir or if the system is a closed loop, fill all lines.

(3) When possible in a supercharged system, start the supercharge pump first to fill the lines. If the supercharge pump cannot be started first, fill the lines by hand or with an auxiliary pumping system.

(4) Bleed the system as the components are operated (jogged) for short periods. When the system appears under control, cycle it slowly until all air is removed.

(5) If leaks appear, repair them and repeat the bleeding procedure.

MAINTENANCE

A. INSPECTION AND SERVICE.

Periodic inspection and service of a hydraulic system can prevent time consuming breakdowns and unnecessary repairs.

(1) Check oil level in the reservoir. Air entering the lines will cause extensive damage to components. Check all lines for leaks for the same reason.

(2) Check and replace filter elements periodically. A clogged filter element results in a higher pressure drop which will force contamination particles through. If the drop is great enough to operate the by-pass valve, a loss of filtration occurs.

(3) Check the condition of the fluid. Contaminated fluid should be drained and replaced.

(4) Check operating pressures and settings of relief valves. A clogged relief valve can result in overload and failure of a pump or motor.

B. TROUBLE SHOOTING.

A hydraulic pump or motor exhibiting an excessive increase in heat, leakage, or noise is a potential failure. When any of these conditions are noticed, shut down the machine, locate and correct the trouble.

Tables III and IV list some common difficulties and remedies.

TABLE III. TROUBLE SHOOTING PUMPS

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	Reservoir fluid level low.	Add fluid and check level off both sides of reservoir baffle to insure pump inlet line is submerged.
	Inlet filter or pipe plugged.	Clean or replace filter. Clean inlet pipe.

TABLE III. TROUBLE SHOOTING PUMPS (Cont'd)

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID (CONTINUED)	Air leak in inlet line prevents priming and irregular control circuit action.	Pour fluid on inlet joints while listening for change in sound of operation. Tighten as required.
	Coupling or shaft sheared or disengaged.	Disassemble pump and check shaft and rotating group for damage. Replace necessary parts.
	Pump driven in wrong direction.	Check installation. Reverse the drive or convert pump.
SYSTEM NOT DEVELOPING CORRECT PRESSURE	Pump not delivering fluid for any of the above reasons.	Check circulation by watching fluid in reservoir.
	Relief valve setting not high enough.	Block machine travel. Test with pressure gauge.
	Relief valve sticking open.	Remove contamination in relief valve.
	Leak in hydraulic control system (cylinders or valves).	Test independently by progressively blocking off the circuit.
	Free re-circulation of fluid to reservoir.	Make certain that directional valve is not in open center (neutral) position or that fluid is not discharging to tank through an open line or improperly adjusted valve.
	Control system malfunction.	Check and repair auxiliary pump, cylinders, or control unit.
PUMP MAKING NOISE	Partly clogged inlet line, filter, or restricted inlet pipe.	Pump must receive fluid freely or cavitation takes place. Clean or replace filter. Clean lines. Refer to installation drawings for intake line size.
	Air leak at pump inlet pipe joints.	Tighten as required. Pour fluid on joints while listening for change in sound of operation.
	Air bubbles in fluid.	Check to be certain return lines are below fluid level and well separated from inlet line.
	Reservoir air vent plugged.	Must be open through breather opening or air filter.
	Pump running too fast.	Conform with recommended maximum speeds on installation drawings.
	Filter too small on inlet.	Refer to appropriate installation drawing for proper size filter.
	Coupling misalignment.	Check for damaged shaft bearing or other parts. If necessary, replace and realign the coupled shafts.

TABLE IV. TROUBLE SHOOTING MOTORS

TROUBLE	PROBABLE CAUSE	REMEDY
MOTOR SHAFT NOT TURNING OR NOT DEVELOPING SUFFICIENT SPEED OR POWER	System overload relief valve set too low to permit necessary pressure.	Check pressure and increase relief valve setting, but not above recommended maximum.
	Excessive work load.	Check circuit design.
	Valve plate and cylinder block surface scored by abrasive in hydraulic fluid.	Remove motor for lapping of valve plate and cylinder block surfaces or installation of new parts. Flush system with clean oil.
MOTOR TURNING IN WRONG DIRECTION	Fluid pressure to wrong port.	Check installation and correct discrepancy. Check directional control and pump stroke position.
EXTERNAL LEAKAGE FROM MOTOR	Worn seal or gaskets.	Install new seal and/or gaskets.
SPEED FLUCTUATIONS WITH CONSTANT INPUT FLOW	Irregular wear between valve plate and cylinder block.	Lap or replace valve plate and cylinder block.

OVERHAUL

NOTE

The size and construction of the PVA/MVA units necessitates the use of special fixtures and facilities for a complete overhaul. These items are discussed in the overhaul procedure which should be read prior to attempting an overhaul.

A. GENERAL.

WARNING

Before breaking a circuit connection, be certain that the electric power is off and all system pressure is relieved. Lower all vertical cylinders and block any load whose movement could generate pressure.

Drain the fluid and clean the housing. Disconnect the unit from the circuit and cap all exposed lines to prevent dirt from entering the system.

Each unit weighs approximately 1100 pounds exclusive of the control system. Mechanical assistance in the form of chain hoists, lift trucks, etc., will be required to handle and transport the unit to the repair area.

B. CONTROL SYSTEM REMOVAL.

One of four different yoke control systems will be part of your unit. An auxiliary pump which is part of the control system or used for another purpose may also be on the unit. The control and auxiliary pump must be removed before overhaul of the unit is started. Refer to the appropriate installation drawing listed in Table II during performance of this paragraph.

(1) Remove the cover and gasket from the main unit. (See figure 2.) Using pieces of wood on both top and bottom, block the yoke in a center (horizontal) position.

(2) Remove the yoke position indicator from the flange (except hydro-mechanical control system units). The yoke indicator on hydro-mechanical control systems is part of the control unit and will be removed as an integral part.

(3) Remove the yoke positioning cylinders and control unit including all lines. Remove the potentiometer transmitter (yoke position feedback) assembly from electro-hydraulic control systems.

(4) Remove the cover from auxiliary pump bracket. (See figure 2.) Remove the tension adjusting screw and the screws holding the auxiliary pump and mounting plate to the bracket. Holding the chain up, tilt the pump down to free it from the chain and remove the pump. Remove the auxiliary pump bracket from the main unit housing.

C. MAIN UNIT DISASSEMBLY.

NOTE

A specially constructed wooden cradle should be used in order to position the unit with the drive shaft vertically down.

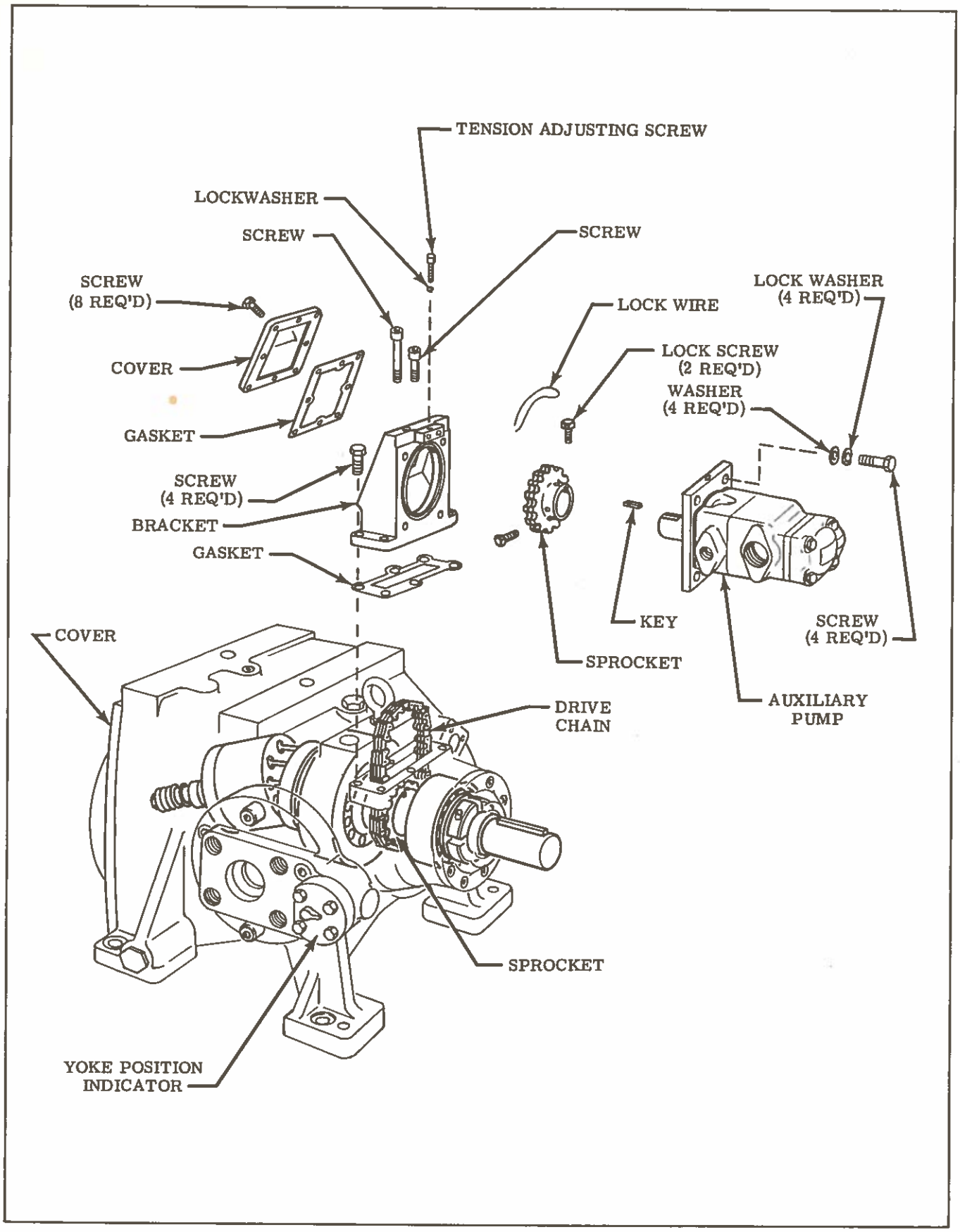


Figure 2. Auxiliary Pump and Mounting

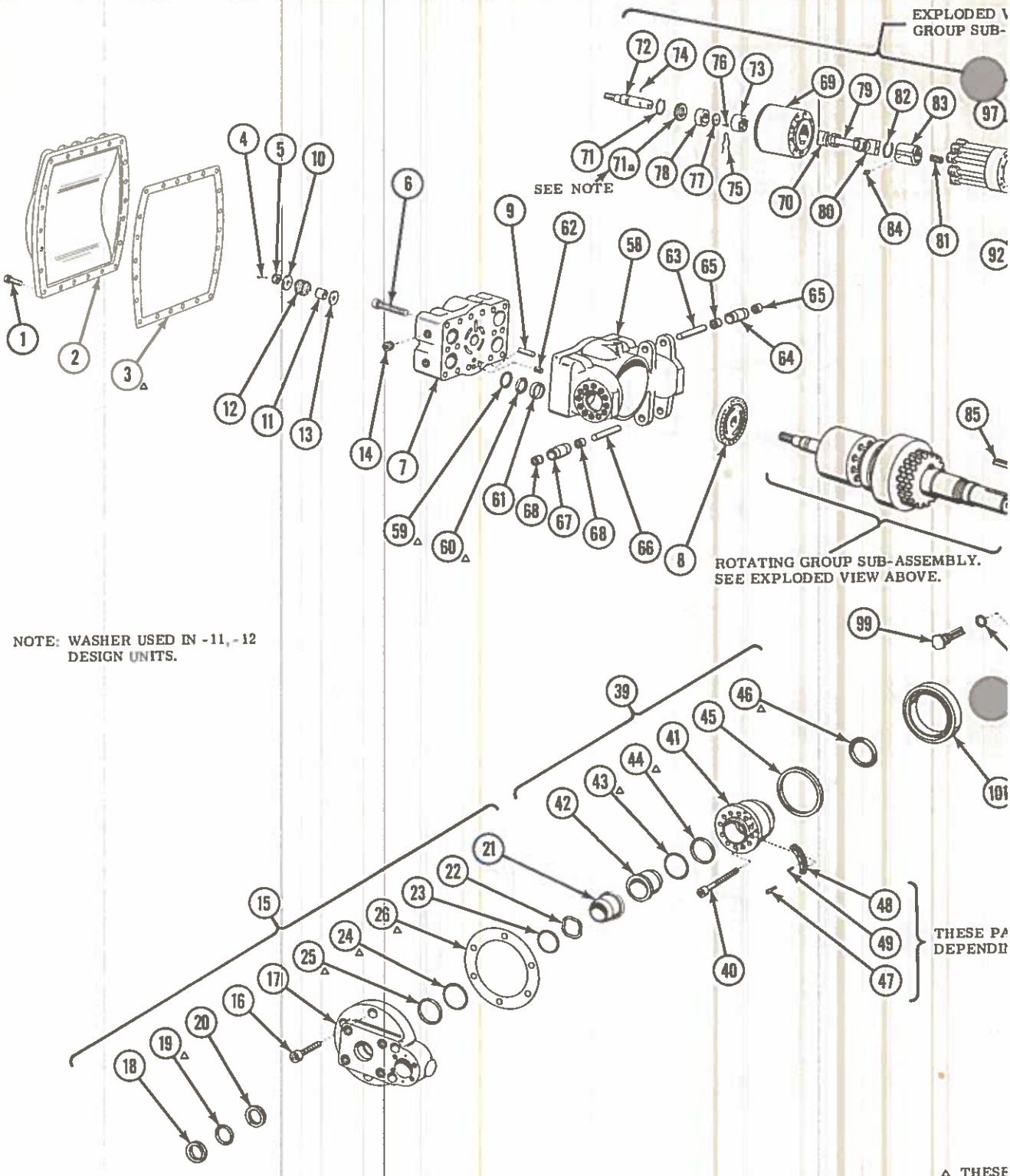
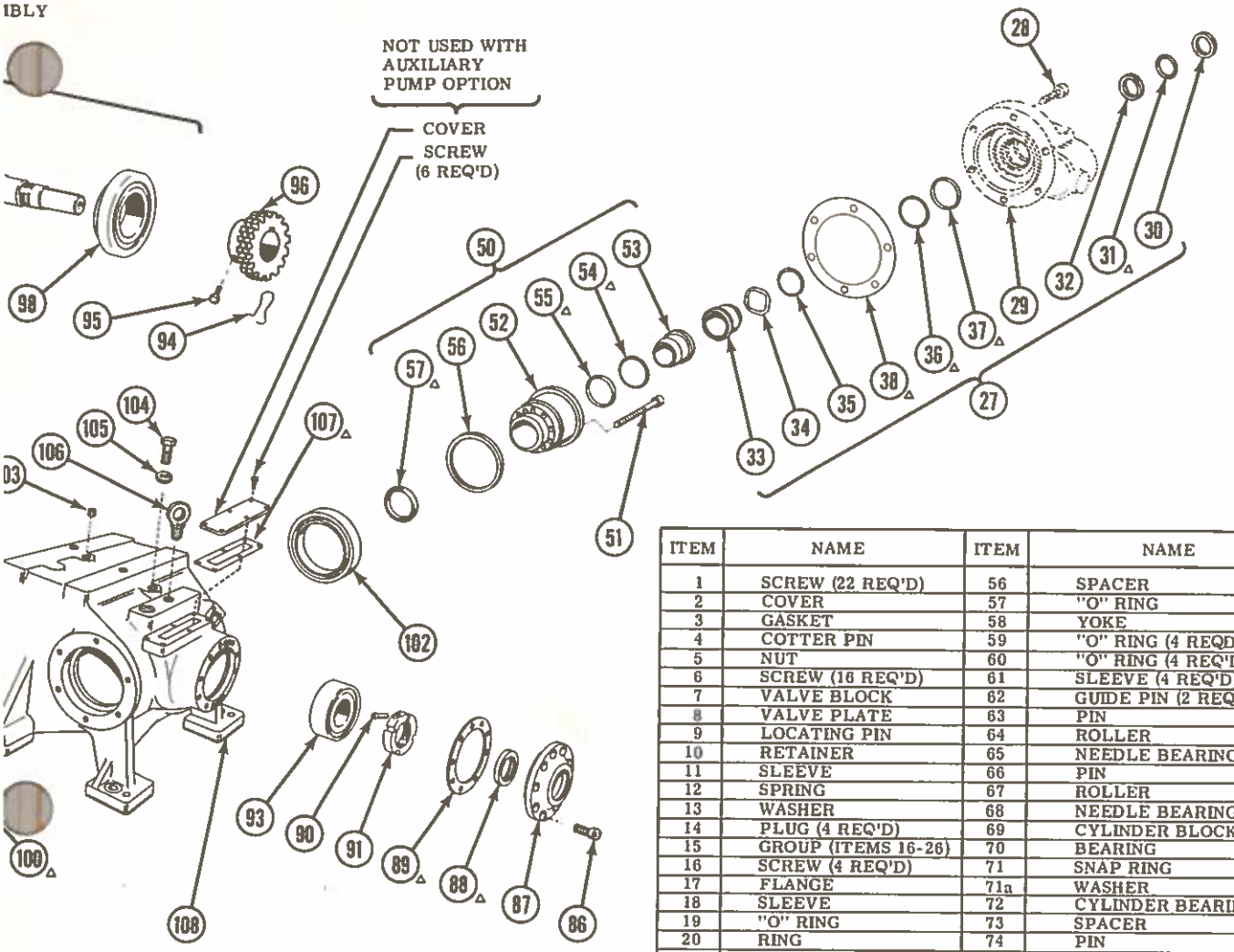


Figure 3. Exploded Parts View

)F ROTATING
IBLY



ITEM	NAME	ITEM	NAME
1	SCREW (22 REQ'D)	56	SPACER
2	COVER	57	"O" RING
3	GASKET	58	YOKE
4	COTTER PIN	59	"O" RING (4 REQD)
5	NUT	60	"O" RING (4 REQ'D)
6	SCREW (16 REQ'D)	61	SLEEVE (4 REQ'D)
7	VALVE BLOCK	62	GUIDE PIN (2 REQ'D)
8	VALVE PLATE	63	PIN
9	LOCATING PIN	64	ROLLER
10	RETAINER	65	NEEDLE BEARINGS
11	SLEEVE	66	PIN
12	SPRING	67	ROLLER
13	WASHER	68	NEEDLE BEARINGS
14	PLUG (4 REQ'D)	69	CYLINDER BLOCK
15	GROUP (ITEMS 16-26)	70	BEARING
16	SCREW (4 REQ'D)	71	SNAP RING
17	FLANGE	71a	WASHER
18	SLEEVE	72	CYLINDER BEARING PIN
19	"O" RING	73	SPACER
20	RING	74	PIN
21	RING	75	LOCK WIRE
22	WAVE WASHER	76	SCREW (2 REQ'D)
23	SHIM (AS REQ'D)	77	RETAINER
24	BACK-UP RING	78	BEARING
25	"O" RING	79	UNIVERSAL LINK
26	GASKET	80	BEARING
27	GROUP (ITEMS 28-38)	81	SPRING
28	SCREW	82	SNAP RING
29	FLANGE	83	RETAINER
30	SLEEVE	84	KEY
31	"O" RING	85	KEY
32	RING	86	SCREW (9 REQ'D)
33	RING	87	SEAL RETAINER
34	WAVE WASHER	88	SEAL
35	SHIM (AS REQ'D)	89	GASKET
36	BACK-UP RING	90	LOCK SCREW
37	"O" RING	91	SHAFT RETAINER NUT
38	GASKET	92	DRIVE SHAFT SUB-ASSY
39	GROUP (ITEMS 40-49)	93	BEARING
40	SCREW (12 REQ'D)	94	LOCK WIRE
41	PINTLE	95	SCREW (2 REQ'D)
42	RING	96	SPROCKET
43	BACK-UP RING	97	KEY
44	"O" RING	98	BEARING
45	SPACER	99	MAGNETIC PLUG (2 REQ'D)
46	"O" RING	100	"O" RING (2 REQ'D)
47	SCREW (2 REQ'D)	101	BEARING
48	GEAR SECTOR	102	BEARING
49	PIN (2 REQ'D)	103	PLUG
50	GROUP (ITEMS 51-57)	104	SCREW (2 REQ'D)
51	SCREW (12 REQ'D)	105	SHIM WASHER (AS REQ'D)
52	PINTLE	106	EYE BOLT
53	RING	107	GASKET
54	BACK-UP RING	108	HOUSING
55	"O" RING	109	

' BE ON OPPOSITE PINTLE OR BOTH PINTLES
)NTROL ASSEMBLY.

.RE AVAILABLE IN KIT FORM.
.E PARTS DRAWING LISTED IN TABLE II.

(1) Carefully position the unit in a wooden cradle with the drive shaft down.

(2) Remove the cotter pin (4, figure 3) and nut (5) from the cylinder bearing pin.

(3) Remove the sixteen screws (6) and remove the valve block (7), while pressing against the cylinder bearing pin (72) to prevent cylinder block (69) removal. Remove the valve plate (8). Remove the valve plate locating pin (9), retainer (10), sleeve (11), spring (12), and washer (13).

(4) Screw two eyebolts into extreme ends of the yoke (58) and connect a chain hoist to the eyebolts. Tighten the chain enough to support the yoke in center position and remove the wooden blocks.

(5) Carefully remove the inlet and outlet flange groups (15) and (27). The pintle ring surfaces must not be damaged.

NOTE

Keep the associated parts for each flange and pintle in separate groups. The shims, if any, for each have been selected for proper clearance. They are marked with "R" for right side and "L" for left side. Note their positions with respect to the housing as shown in figure 3.

(6) Remove the pintle groups (39) and (50). The twenty-four securing screws (40) and (51) will require a more than normal effort to remove because of a sealer used on the threads.

(7) Slowly lift the yoke (58) with the chain hoist. Grasp the cylinder block (69) as it becomes exposed to prevent it from falling against the housing or from being pulled away from the pistons. Continue to raise the yoke and remove it.

(8) Remove the eight "O" rings (59 and 60), four sleeves (61), and two valve block guide pins (62) from the yoke. If damaged, remove the rollers (64 and 67) by driving the pins (63 and 66) out.

CAUTION

Do not let the pistons strike the housing or each other when removing the cylinder block in the following step. A minor burr on the pistons can cause severe damage to the cylinder bores.

(9) Tilt the cylinder block (69) and slowly pull it out, catching each piston and the universal link (79) as they clear the bores.

(10) Remove the universal link bearing (70).

(11) Remove the snap ring (71) and pull the cylinder bearing pin (72) out of the cylinder block. Remove washer (71a) on -11 and -12 design units. Remove the spacer (73). Remove the pin (74), lock wire (75), two screws (76), retainer (77), and bearing (78) from the cylinder bearing pin.

(12) Remove the universal link (79) from the drive shaft and piston subassembly.

NOTE

Protect the pistons by placing a piece of plastic or rubber tubing over each one.

(13) Remove the unit from the wooden cradle and set it upright on the housing legs.

(14) Remove the universal link bearing (80), spring (81), snap ring (82), retainer (83), and key (84) from the drive shaft and piston subassembly.

(15) Remove the key (85) from the drive shaft. Remove the nine screws (86), seal retainer (87), seal (88), and gasket (89).

NOTE

Replacement of the drive shaft subassembly and bearings requires special facilities. Because of this, removal is not recommended unless wear of the pistons or bearings dictates replacement. The special fixture required to remove the drive shaft subassembly is shown in figure 4.

(16) Loosen the lock screw (90) and remove the shaft retainer nut (91) from the drive shaft.

(17) If an auxiliary pump was on the unit, place the drive chain clear of the sprocket during drive shaft removal.

(18) Fasten the fixture block, with backing plate, squarely against the drive shaft with the four 5/8 inch bolts. (See figure 4.) Make certain that the pistons are free to move back. Force the drive shaft free of the housing by turning the 1 inch bolt.

(19) Remove the lockwire (94) and loosen the two lock screws (95). Slide the sprocket (96) from the drive shaft. Remove the key (97).

(20) Force the large bearing (98) from the drive shaft by installing three 1/2-13 UNC bolts in the equally spaced holes in the piston and rod end. Tighten the bolts alternately to force the bearing off.

(21) If the drive shaft bearing races which remain in the housing are to be removed, use a large brass rod to drive them out. These races must be replaced if the bearings are replaced. Alternately strike the race on different sectors when driving it out.

(22) Unscrew the magnetic plugs (99) from the housing.

(23) Press the pintle bearings (101 and 102) from the housing if required.

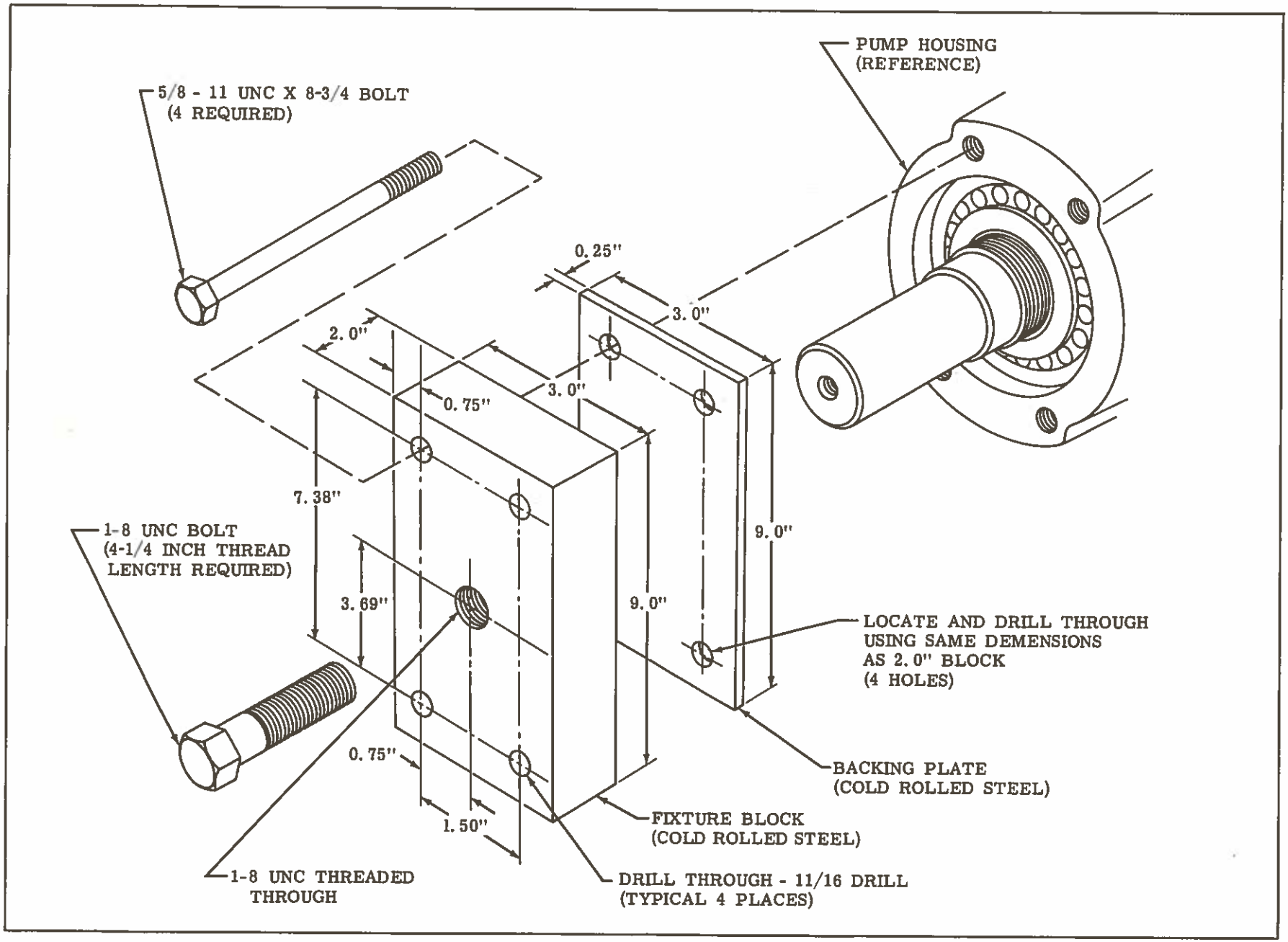


Figure 4. Drive Shaft Removal Fixture

D. INSPECTION AND REPAIR.

All parts must be thoroughly cleaned and kept clean during inspection and assembly. Contamination in the unit will cause excessive wear, leakage, and decreased service life. Use a commercial cleaning solvent which is compatible with the system fluid. Thoroughly clean any part after it is machined or lapped. Use of compressed air to dry the parts after cleaning is not recommended unless the system is completely filtered to remove water and contamination.

(1) Check that all internal passages are clean and unobstructed. Examine all mating surfaces for nicks and burrs. Check locating pins and holes for wear and burrs. Check the condition of threaded parts and threaded holes. Check all snap ring recesses. Minor burrs can be removed with an India stone. Replace any part which shows excessive wear or damage.

(2) Inspect all ball, roller, and needle bearings for excessive wear or roughness when turned by hand. Inspect the universal link (79) and bearings (70 and 80). Replace parts that are damaged or show excessive wear.

NOTE

If the drive shaft bearings are to be replaced, the outer races which fit in the housing must also be replaced. Each bearing with its respective outer race is supplied as a unit.

(3) Inspect the mating surfaces of the pintle rings (21 and 42, 33 and 53). These sealing surfaces must be flat and burr free. Repair minor damage by lapping the surfaces. Check the surface flatness after lapping.

(4) Inspect the bores of the cylinder block (69) for scoring and wear. The mating surfaces between the valve block (7), valve plate (8), and cylinder block (69) must be smooth, flat, and parallel to each other. Minor damage to the surfaces can be repaired by lapping. Machining is not recommended. A special surface hardness for wear resistance would be removed by excessive material removal. The one exception is the bronze cylinder block which is in later design units and some converted units. A maximum of 0.010 inch can be removed from the bronze block. Lap the block after machining to obtain a smooth surface. Check all surfaces for flatness after lapping.

(5) Inspect the pistons for wear and burrs. Remove minor burrs with an India stone. Make certain that the piston and rods are free to swivel. Check for wear of the piston and rod assemblies by pushing on each piston. If looseness or excessive damage is detected, replace the piston and drive shaft subassembly.

E. MAIN UNIT ASSEMBLY.

Assembly order sequence is basically in reverse of disassembly, however, clearance tolerances and special instructions are contained in the following steps. During assembly, install new gaskets, "O" rings, and seals. A gasket kit containing these items is available. (See applicable parts drawing listed in Table II.) Lubricate all bearings, "O" rings, seals, and wear surfaces with clean hydraulic fluid during assembly.

(1) Press the pintle bearings (101 and 102) into the housing if they have been removed. The wide shoulder of the outer race must face the inside of the housing.

(2) Install the two magnetic plugs and "O" rings (99 and 100).

NOTE

If the drive shaft bearings (98 and 93) have been removed, the new outer races must be chilled by dry ice or other means for insertion. Cooling will shrink the race allowing positive insertion into the housing. The inner races (containing the rollers) must be heated at 250°F for approximately an hour to allow positive installation onto the drive shaft.

(3) Seat the chilled drive shaft bearing races firmly in the housing.

(4) Place a protective sleeve over each piston to prevent damage to the pistons during handling.

(5) Install the large heated bearing (98) on the drive shaft, seating it firmly against the shoulder.

(6) When the drive shaft and bearing are cool enough for handling, install the key (97), sprocket (96), and two lock screws (95). Seat the sprocket firmly against the shoulder and lockwire the screws after tightening.

NOTE

If the auxiliary pump drive chain has not been taken apart, feed it into the housing opening and insert the drive shaft through it in the following step.

(7) Place the drive shaft in the housing and install the heated small drive shaft bearing (93).

(8) Install the drive shaft retainer nut (91). Tighten the nut so that the drive shaft subassembly and front bearing are clamped snugly together (no shaft end play). Screw an eyebolt into the drive shaft and carefully lift the unit with a chain hoist. While the unit is suspended by the drive shaft, back off the retainer nut until 0.003 to 0.005 inch of clearance is measured between the retainer nut and front bearing. (See figure 5.) Install and tighten the lockscrew (90). Recheck the clearance and repeat the procedure if necessary. Lower the unit, remove the eyebolt and tap the end of the shaft until the retainer nut is flush against the bearing.

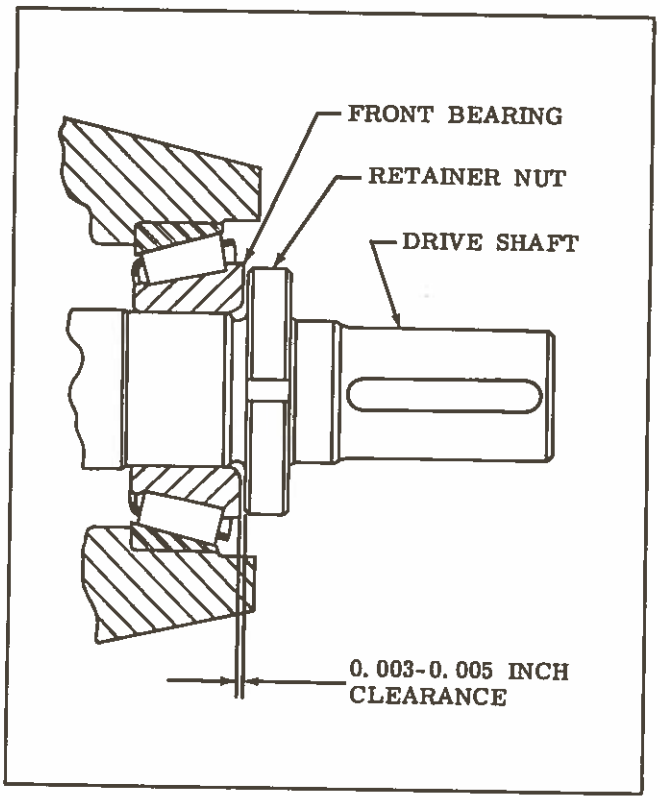


Figure 5. Drive Shaft End-Play Adjustment

(9) Install a new seal (88) in the retainer (87) and then install the retainer, with gasket (89), on the housing. Replace the drive shaft key (85).

(10) Place the unit, drive shaft down, in the wooden cradle.

(11) Install the key (84), retainer (83), snap ring (82), and spring (81). Coat the inside of the retainer, the universal link knuckles (79), and the bearing (80), with a liberal amount of "Molykote G" (manufactured by Alpha Molykote Corporation). Install the bearing (80) and universal link (79).

CAUTION

Make certain that the filling notches of the bearing (78) face the retainer (77) when assembling.

(12) Assemble the cylinder bearing pin (72), bearing (78), retainer (77) and two screws (76). Lockwire the screws after tightening. Install pin (74) into the cylinder bearing pin.

(13) Insert the spacer (73) into the cylinder block (69). Insert the cylinder bearing pin (and washer 71a if -11 or -12 design unit). Secure with snap ring (71). Liberally coat the universal link bearing (70) with "Molykote G"and insert it into the cylinder block.

(14) Remove the protective sleeves from the pistons and recheck each one for nicks and burrs. Lubricate each piston with clean hydraulic oil.

(15) Lubricate each cylinder bore with clean hydraulic fluid. Insert No. 1 piston (figure 6) in No. 1 cylinder bore. Alternately insert adjacent pistons until two remain to be inserted. Tilt the block and insert the universal link. Insert the two remaining pistons. Check the assembly by pressing down on the cylinder block. Action should be smooth and springy. Rotate the cylinder bearing pin and check for smooth operation.

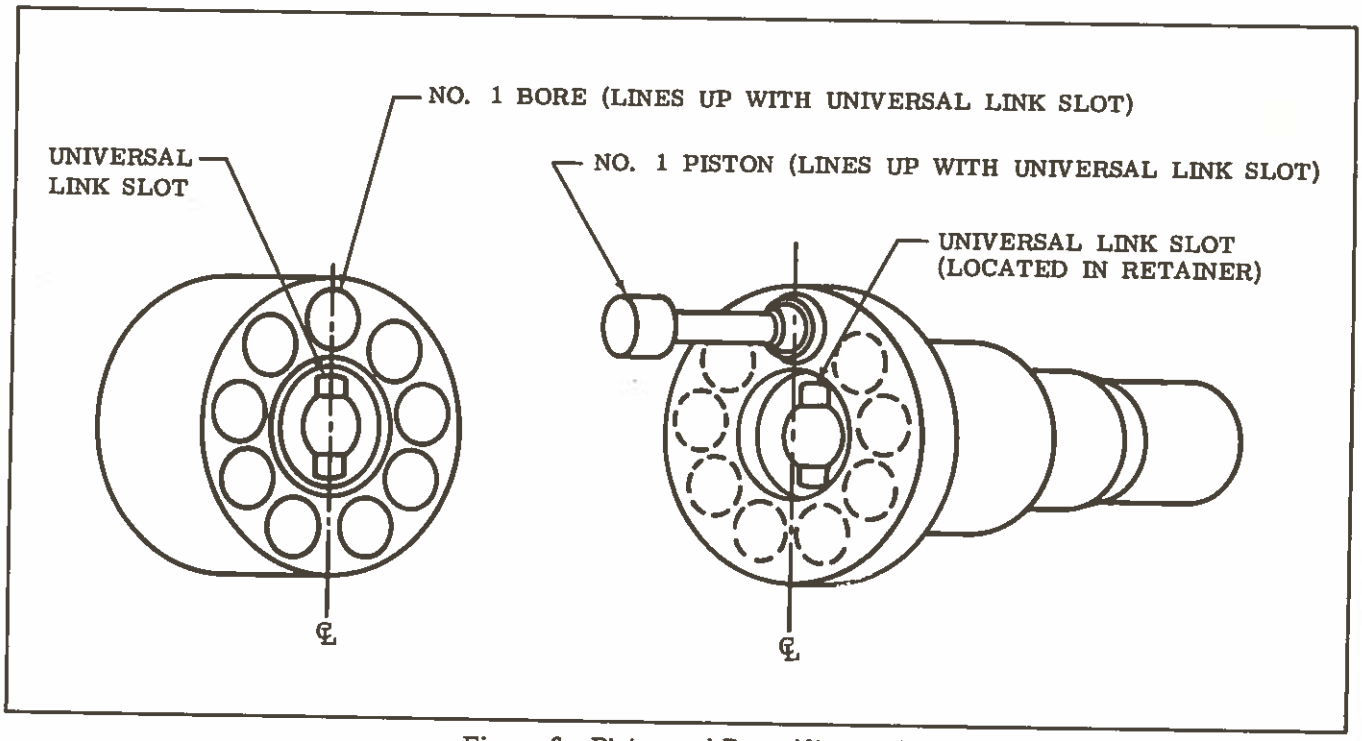


Figure 6. Piston and Bore Alignment.

(16) Assemble the rollers (64 and 67), bearings (65 and 68), and pins (63 and 66) into the yoke (58) if they have been removed. Stake the edges of the yoke pin holes with a center punch after assembly.

(17) Install two eyebolts in extreme ends of the yoke (58) and connect to the chain hoist. Slowly lower the yoke into the housing while guiding the cylinder block into the yoke opening. Line the yoke up with the pintle openings in the housing.

(18) Assemble and install pintle groups (39) and (50). Make certain that each group is installed in the same side from which it was removed as noted in paragraph C.(5). Use "Loctite, grade CV(4-10)" (manufactured by American Sealants Company) on the screw threads and torque to 70-80 foot pounds.

(19) Assemble the flange groups (15 and 27). Test the seating of the pintle rings (21 and 33) by pushing and releasing them in their respective flanges. The action should be smooth and springy. Install the groups, making certain that each group is installed in the same side from which it was removed.

(20) Block the yoke (58) in the center position with two wooden blocks and remove the chain hoist and eyebolts.

(21) Install the four sleeves (61), eight "O" rings (59 and 60), and two valve block guide pins (62) into the yoke. Insert the locating pin (9) into the valve plate (8). Lubricate the mating faces of the valve block (7), valve plate (8), and cylinder block (69) with hydraulic fluid. Align the valve plate with the pin (74) in the cylinder bearing pin (72) and install the valve plate.

NOTE

Assembly will be completed during control system installation.

(22) Remove the unit from the wooden cradle and set it on the housing legs.

F. AUXILIARY PUMP INSTALLATION.

NOTE

On units containing an auxiliary pump (figure 2), the alignment of the sprockets must be checked if the sprocket was removed from the auxiliary pump. Check with a straight edge placed against the flat side of the auxiliary pump sprocket and extended through the bracket to the main unit sprocket. If a sprocket adjustment is required, be sure to lockwire the set screws after tightening.

(1) Install the auxiliary pump drive chain if it was not installed during main unit assembly. Install the auxiliary pump bracket and gasket. Holding the drive chain up, tilt the pump down to engage the sprocket with the chain. Install the pump mounting screws finger tight. Insert the tension adjusting screw through the spacer and screw it into the pump mounting plate. Adjust the tension screw for proper chain tension. The chain tension must not place an excessive load on the auxiliary pump drive shaft nor be so loose that the chain will ride out of the sprocket center guides. Tighten the pump mounting screws and recheck.

(2) Install the bracket cover and gasket.

G. HANDWHEEL AND PRESSURE COMPENSATOR CONTROL INSTALLATION.

(1) Install the yoke positioning cylinders, control unit, and lines.

(2) Using the wooden blocks and shims required, block the yoke in exactly center (zero) position. Make certain that the yoke face is exactly parallel with a bar placed vertically against the back of the housing.

(3) Position the yoke indicator pointer to exactly center (zero) indication and install the assembly on the flange. Do not force. The yoke indicator gear and gear rack on the pintle should engage freely.

(4) Install the four plugs (14, figure 3) in the valve block. Align the locating pins (9 and 62) and install the valve block (7). Install the washer (13), spring (12), sleeve (11), retainer (10) and nut (5). Tighten the nut (5) until the valve block, valve plate and cylinder block are clamped snugly together. Back the nut off from 1/6 to 1/4 of a turn. Install the cotter pin (4).

(5) Remove the wooden blocks and shims.

(6) Install the gasket and cover on the main unit.

H. ELECTRO-HYDRAULIC CONTROL INSTALLATION.

(1) Install the yoke positioning cylinders, filter, and lines.

(2) Using the wooden blocks and shims required, block the yoke in exactly center (zero) position. Make certain that the yoke face is exactly parallel with a bar placed vertically against the back of the housing.

(3) Position the yoke indicator pointer to exactly center (zero) indication and install the assembly on the flange. Do not force. The yoke indicator gear and gear rack on the pintle should engage freely.

(4) Install the four plugs (14, figure 3) in the valve block. Align the locating pins (9 and 62) and install the valve block (7). Install the washer (13), spring (12), sleeve (11), retainer (10) and nut (5). Tighten the nut (5) until the valve block, valve plate and cylinder block are clamped snugly together. Back the nut off from 1/6 to 1/4 of a turn. Install the cotter pin (4).

(5) Remove the wooden block from the top of the yoke. Lift the yoke slightly, remove the bottom

wooden block and then allow the yoke to drop slowly against the bottom screw stop.

(6) Align the holes in the anti-backlash gear on the potentiometer transmitter assembly and insert a cotter pin. (See figure 7.) Securely attach a 12 inch piece of wire to the cotter pin and feed the wire through the plug hole in the end of the flange. Install the potentiometer assembly on the flange. The anti-backlash gear and gear rack on the pintle should engage freely. Use an eye-hook tool or screwdriver through the flange plug hole and remove the cotter pin. Retrieve it with the attached wire. Install the plug in the flange hole. Select a range on an ohmmeter that will provide the closest center scale reading for 8070 ohms. Connect the ohmmeter leads to pin A and C on the electrical connector. Loosen the 3 clamps and rotate the potentiometer until a reading of 8070 ohms is obtained (3070 ohms if current limiting resistor is not incorporated). Tighten clamps.

(7) Install the cover and gasket on the main unit.

I. HYDRO-MECHANICAL CONTROL INSTALLATION.

(1) Install the yoke positioning cylinders.

(2) Using the wooden blocks and shims required, block the yoke in exactly center (zero) position. Make certain that the yoke face is exactly parallel with a bar placed vertically against the back of the housing.

(3) Position the pointer on the control unit to exactly zero indication and then install the unit. Do not force. The yoke indicator gear and gear rack on the pintle should engage freely.

(4) Install all control lines.

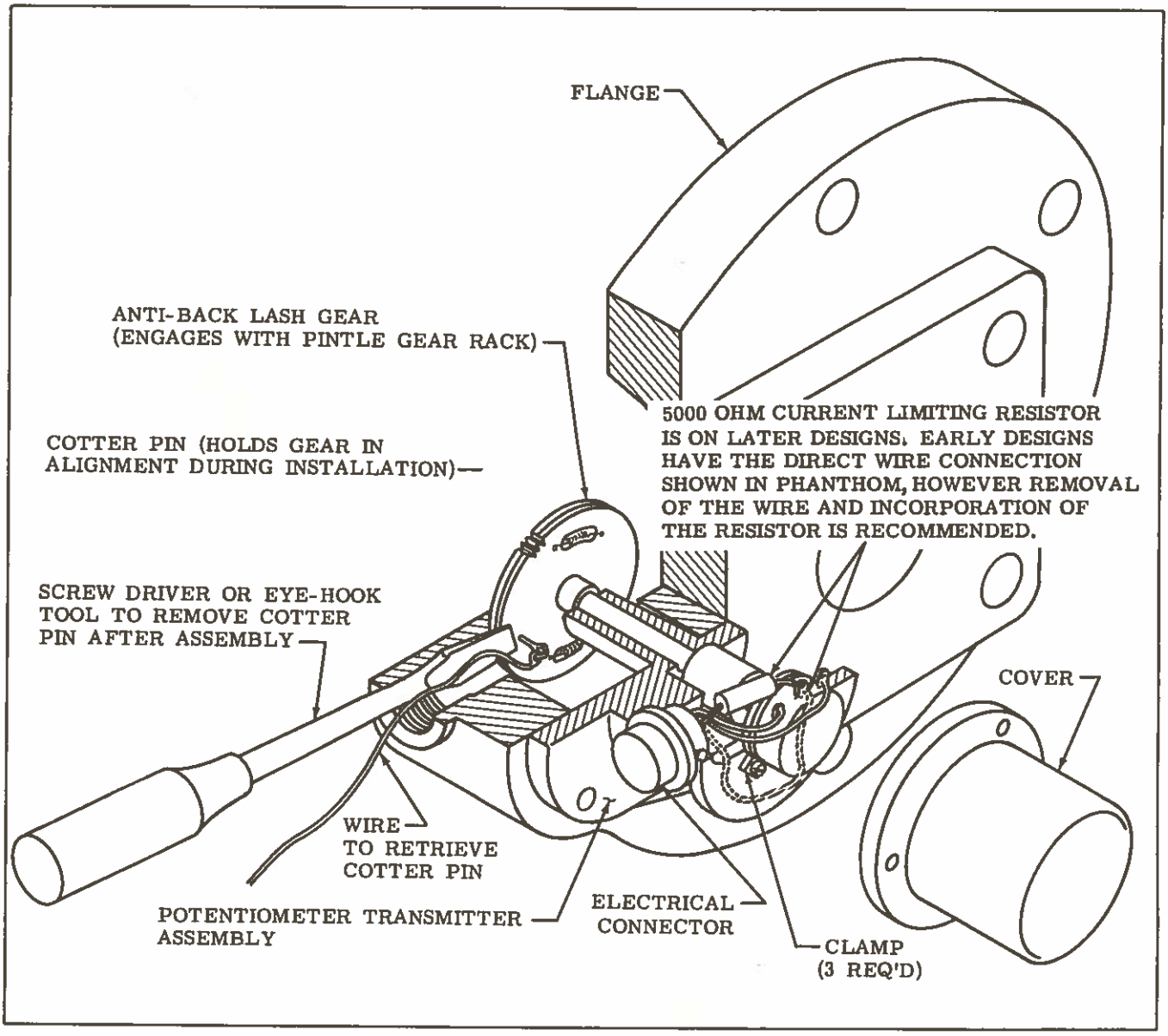


Figure 7. Potentiometer Transmitter Assembly Installation

(5) Refer to figure 3. Install the plugs (14) in the valve block. Align the locating pins (9 and 62) and install the valve block (7). Install the washer (13), spring (12), sleeve (11), retainer (10) and nut (5). Tighten the nut (5) until the valve block, valve plate and cylinder block are clamped snugly together. Back the nut off from 1/6 to 1/4 of a turn. Install the cotter pin (4).

(6) Remove the wooden block from the top of the yoke. Lift the yoke slightly, remove the shims and bottom wooden block and then allow the yoke to drop slowly against the bottom screw stop.

(7) Install the gasket and back cover on the unit.

J. CIRCUIT INSTALLATION. Connect all lines and electrical wiring. Refer to the INSTALLATION section for starting and priming instructions.

CAUTION

The housing must be filled with fluid prior to start up.

K. CONVERSION. Change the valve plate in the unit whenever a circuit change is made which requires reverse rotation. Refer to the appropriate parts drawing, listed in Table II, for the correct valve plate. Remember to stamp a revised model code on the nameplate after making the change.

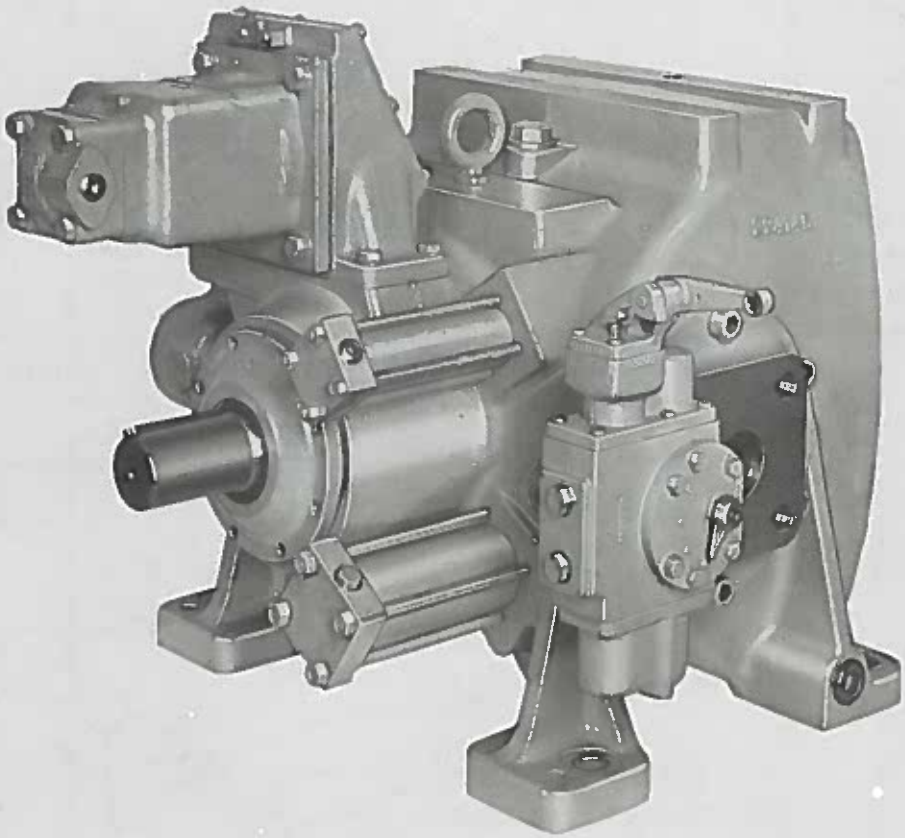
Litho in U. S. A.

VICKERS®
A TRINOVA COMPANY

Service Parts Information

Variable Delivery Piston Pumps & Motors

PVA12[illegible]**-10/11/12/13/14
MVA12[illegible]-**-10/11/12/13/14



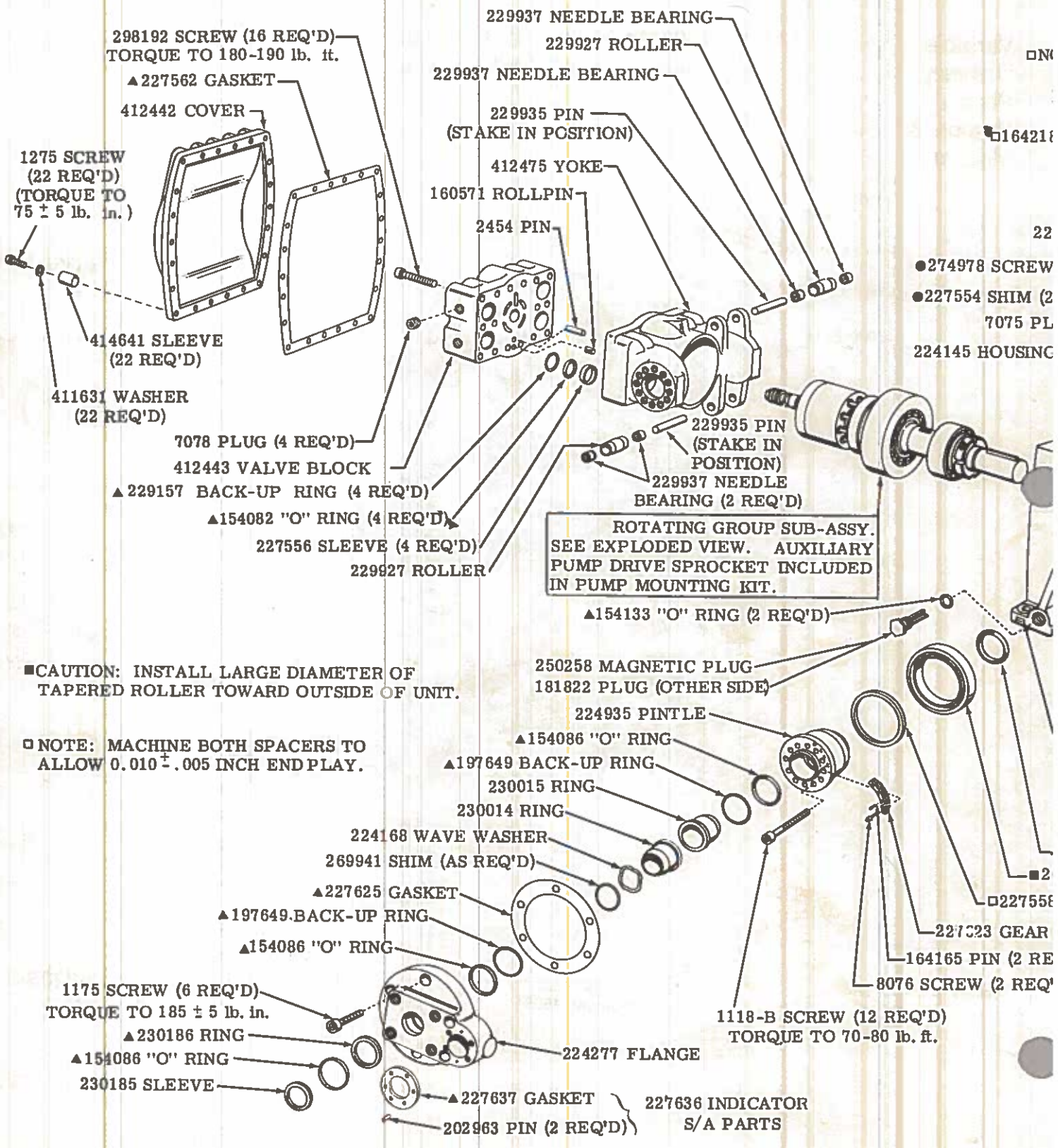
Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 7-1-86 I-3205-S

PVA120--10/11/12/13/14**

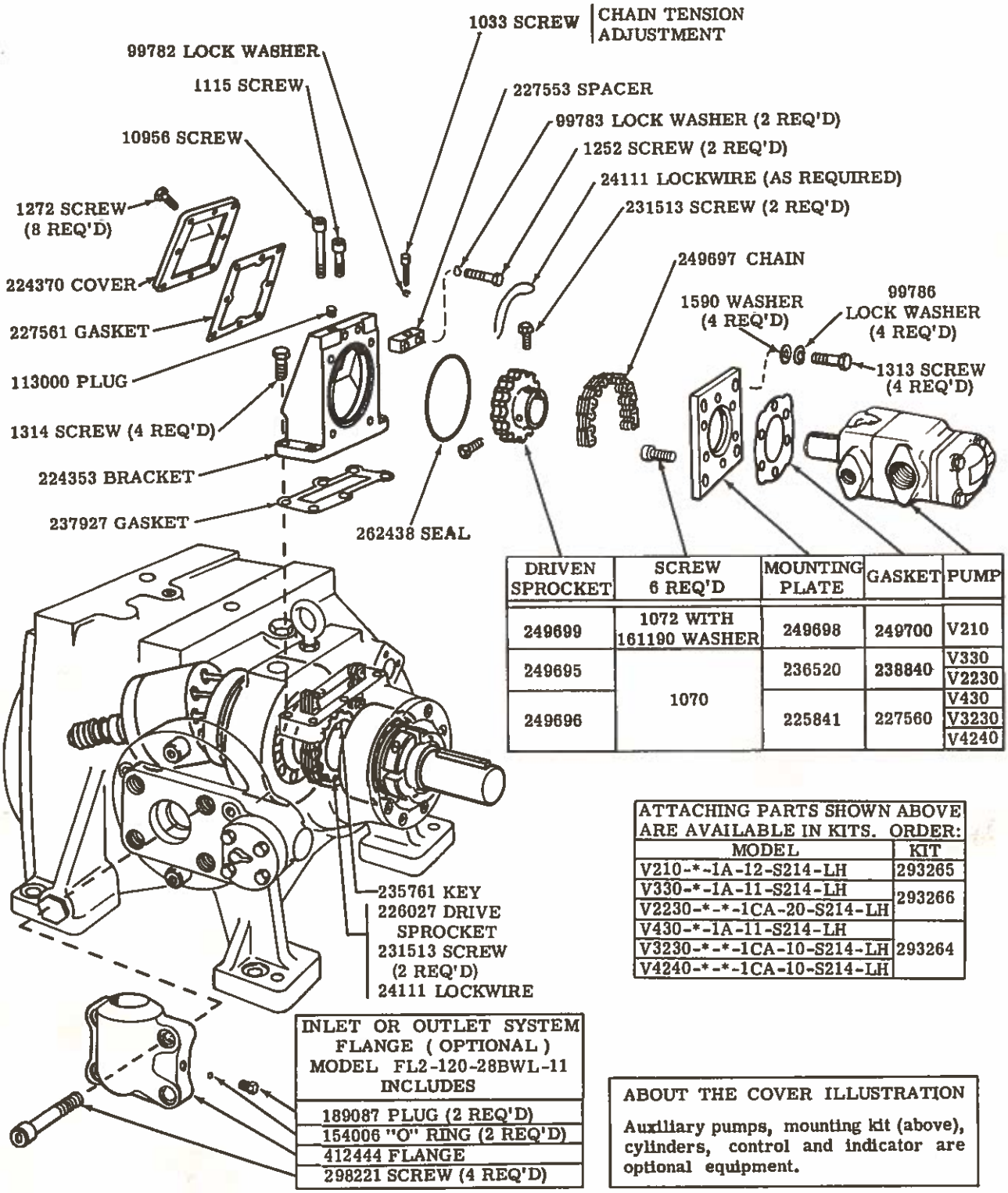
MVA120--10/11/12/13/14**



■CAUTION: INSTALL LARGE DIAMETER OF TAPERED ROLLER TOWARD OUTSIDE OF UNIT.

□NOTE: MACHINE BOTH SPACERS TO ALLOW 0.010 ± .005 INCH END PLAY.

AUXILIARY PUMPS:
ATTACHING PARTS & SYSTEM FLANGES



DRIVEN SPROCKET	SCREW 6 REQ'D	MOUNTING PLATE	GASKET	PUMP
249699	1072 WITH 161190 WASHER	249698	249700	V210
249695	1070	236520	238840	V330 V2230
249696		225841	227560	V430 V3230 V4240

ATTACHING PARTS SHOWN ABOVE ARE AVAILABLE IN KITS. ORDER:	
MODEL	KIT
V210-*-1A-12-S214-LH	293265
V330-*-1A-11-S214-LH	293266
V2230-*-*-1CA-20-S214-LH	
V430-*-1A-11-S214-LH	293264
V3230-*-*-1CA-10-S214-LH	
V4240-*-*-1CA-10-S214-LH	

INLET OR OUTLET SYSTEM FLANGE (OPTIONAL) MODEL FL2-120-28BWL-11 INCLUDES
189087 PLUG (2 REQ'D)
154006 "O" RING (2 REQ'D)
412444 FLANGE
298221 SCREW (4 REQ'D)

ABOUT THE COVER ILLUSTRATION

Auxiliary pumps, mounting kit (above), cylinders, control and indicator are optional equipment.

MODEL CODE BREAKDOWN

VA 120-**-1

- P - PUMP
- M - MOTOR

VARIABLE DISPLACEMENT

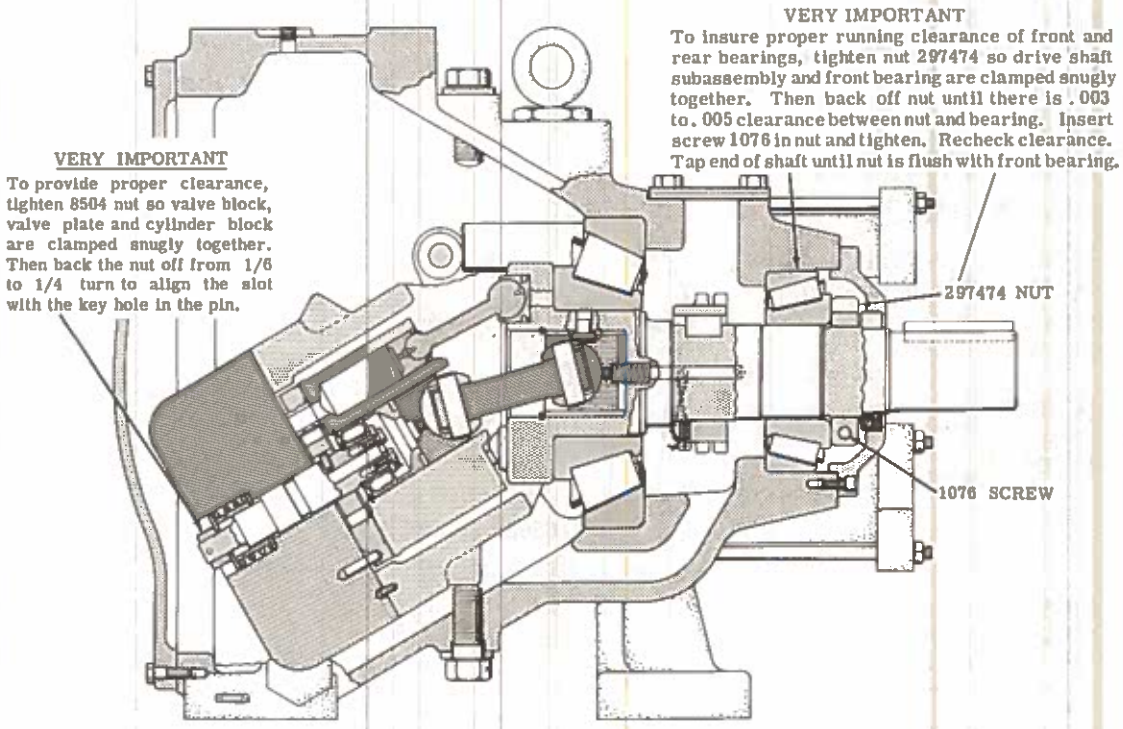
ANGLE TYPE

DELIVERY AT 1200 RPM
120 USGPM

DESIGN

DISPLACEMENT
- S - DISPLACEMENT ONE SIDE OF CENTER
- D - DISPLACEMENT BOTH SIDES OF CENTER

ROTATION
- R - RIGHT HAND
- L - LEFT HAND
- U - EITHER DIRECTION


VERY IMPORTANT
To provide proper clearance, tighten 8504 nut so valve block, valve plate and cylinder block are clamped snugly together. Then back the nut off from 1/6 to 1/4 turn to align the slot with the key hole in the pin.
VERY IMPORTANT
To insure proper running clearance of front and rear bearings, tighten nut 297474 so drive shaft subassembly and front bearing are clamped snugly together. Then back off nut until there is .003 to .005 clearance between nut and bearing. Insert screw 1076 in nut and tighten. Recheck clearance. Tap end of shaft until nut is flush with front bearing.
297474 NUT
1076 SCREW

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

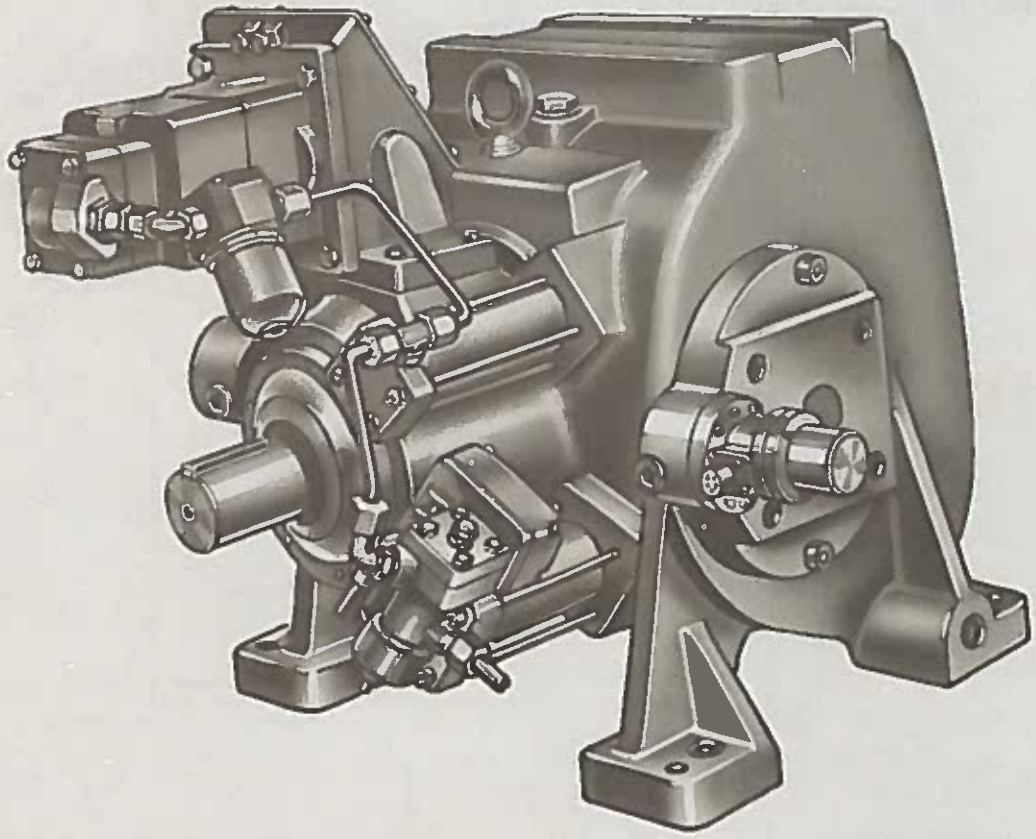
Litho in U. S. A.

VICKERS

Service Parts Information

Electrohydraulic Controls
PVA-120/150
MVA-120/150

CAM-SR(*)7-10/11/12
CAM-SS7-10/11/12
CAP-DR(*)7-10/11/12
CAP-DS7-10/11/12
CAP-SS7-10/11
CAP-SR(*)7-10/11/12



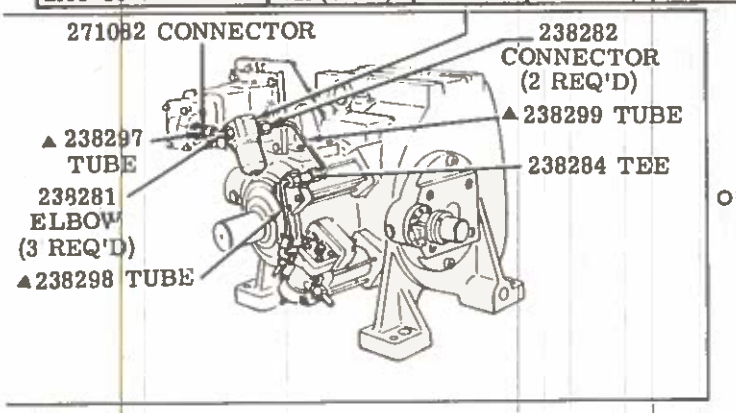
Vickers, Incorporated
1401 Crooks Road
Troy, Michigan 48084

Revised 9-1-86

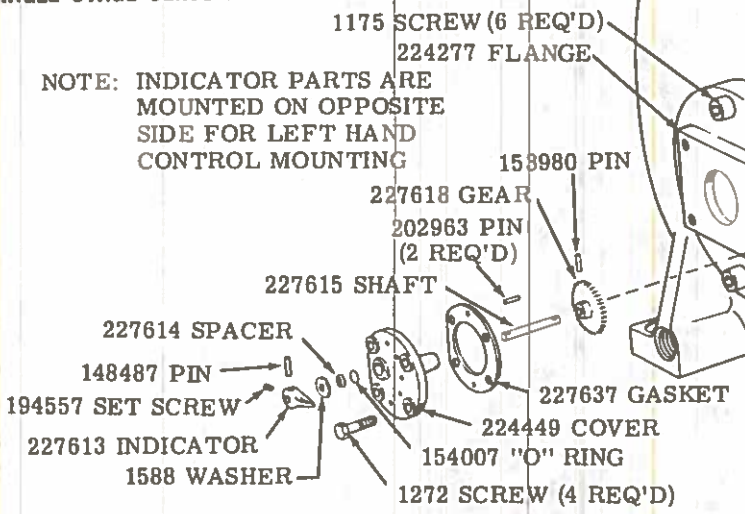
I-3206-S

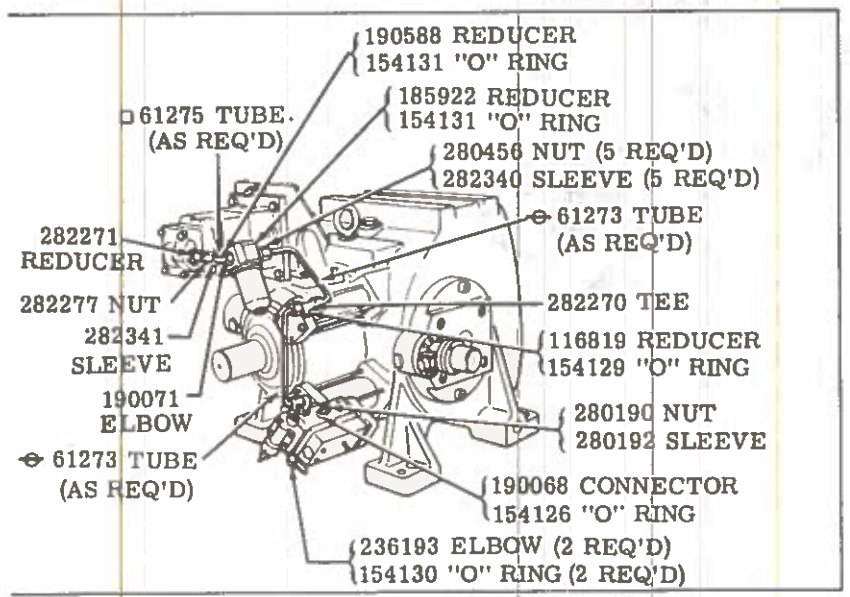
ELECTRO-HYDRAULIC CONTROLS FOR PVA-120, MVA-120—10/11/12 DESIGN PVA-150, MVA-150—10/11/12 DESIGN

MODEL OF SERVO	CAPACITY (GPM)	FILTER ASSY.	"O" RING	FILTER ELEMENT	CONN. TUBING & FITTING S/A
SC4-03-***-**	6(GPM)	176017	154016	134727	237985
SA4-03-**-***-**	12(GPM)	140113	154018	147930	282259

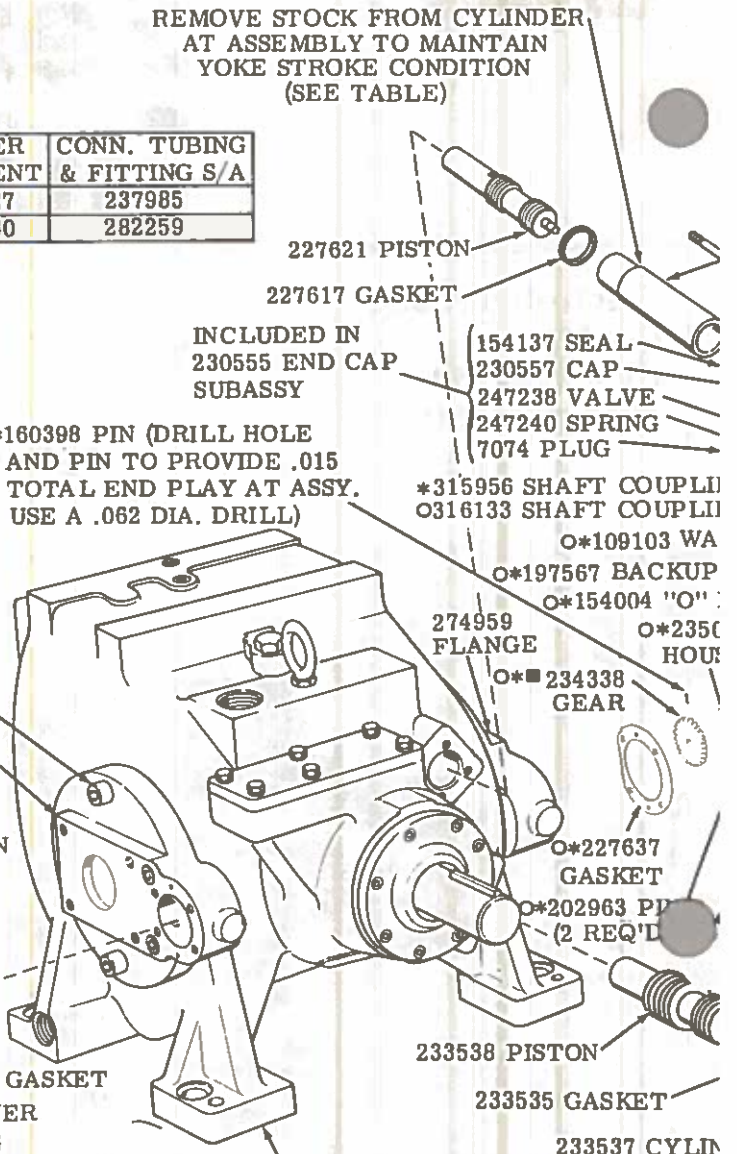


SINGLE STAGE SERVO PIPING CONNECTIONS





TWO STAGE SERVO PIPING CONNECTIONS



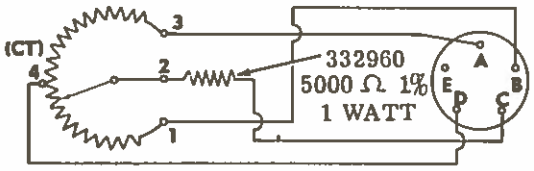
BASIC PUMP PARTS, PLUS AUXILIARY VANE PUMP AND VANE PUMP MOUNTING PARTS, ARE SHOWN ON PARTS DRAWING:
I-3205-S ---- PVA120/MVA120
I-3207-S ---- PVA150/MVA150

HYDRAULIC TUBING
□ .75 O.D.X.065 WALL SEAMLESS STEEL
⊖ .625 O.D.X.058 WALL SEAMLESS STEEL
▲ .5 O.D.X.05 WALL SEAMLESS STEEL

NOTE: SEE BACK OF PAGE FOR SERVO AND FEEDBACK CONTROL SUBASSEMBLY PART NUMBER AND CORRESPONDING MODEL NUMBERS.

MODEL	CYLINDER	STUD (4 REQ'D)	STROKE CONDITION
CAM-SR7-10/11	252524	230560	ONE SIDE OF CENTER $5^{o}-30^{o}\ ^{+\frac{1}{2}o}_{-\frac{1}{2}o}$
CAM-SRA7-10/11/12			
CAM-SRC7-11/12			
CAM-SS7-10/11/12			
CAP-DR7-10/11/12	227620	227355	BOTH SIDES OF CENTER $30^{o}-30^{o}\ ^{+\frac{1}{2}o}_{-\frac{1}{2}o}$
CAP-DRA7-10/11/12			
CAP-DRB7-10/11			
CAP-DS7-10/11/12			
CAP-SR7-10/11/12	230561	230560	ONE SIDE OF CENTER $0^{o}\pm\frac{1}{2}^{o}-30^{o}\pm\frac{1}{2}^{o}$
CAP-SRA7-10/11/12			
CAP-SRC7-11/12			
CAP-SS7-10/11			

293263 POTENTIOMETER AND
118404 RECEPTACLE WIRING SCHEMATIC

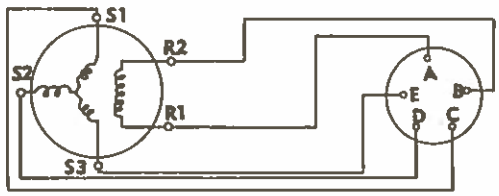


(293263) (118404)

NOTE
BARE WIRES MUST BE TAPED OR OTHERWISE PROTECTED TO PREVENT SHORTING TO METAL PARTS.

"OR"

234462 SYNCHRO AND
118404 RECEPTACLE WIRING SCHEMATIC



(234462) (118404)

223201 NUT (4 REQ'D) (TORQUE NUTS TO 310-330 lb. in.)

FEEDBACK CONTROL

* 332960 RESISTOR (POT. FEEDBACK CONTROL ONLY)

○*235061 CLAMP
○*132082 SCREW (3 REQ'D)
○*235062 GASKET
○*235065 COVER
8076 SCREW (3 REQ'D)
○*48982 LOCKWIRE
*293263 POTENTIOMETER (SHOWN) OR
○234462 SYNCHRO
○*240495 CLAMP (SCREW MUST BE ACCESSIBLE THRU RECEPTACLE HOLE WHEN YOKE IS AT 30° (DOWN POSITION))
○*118404 RECEPTACLE
○*234752 SCREW (4 REQ'D)
○*48982 LOCKWIRE

173792 "O" RING (6 REQ'D)

USED ON EARLY DESIGNS. -14 DESIGN DOES NOT REQUIRE THIS PLATE.

●SA4-03-**-***-**
TWO STAGE SERVO
WHEN ORDERING SERVO PARTS USE MODEL STAMPED IN NAMEPLATE.

7074 PLUG
48549 ORIFICE
7076 PLUG
7075 PLUG
247240 SPRING
7074 PLUG
174140 SEAL
7074 PLUG
247238 POPPET
223204 NUT (4 REQ'D)
TORQUE TO 520 ± 10 lb. in.
178993 PLATE
154005 "O" RING (4 REQ'D)
281948 END CAP
154005 "O" RING
1258 SCREWS (4 REQ'D)
178993 PLATE & 174916 SPACER EXISTS ON EARLY MODELS ONLY
SUPPLIED WITH VALVE. ALSO AVAILABLE SEPARATELY.
●CG-03-**-10 HIGH PRESSURE RELEIF VALVE
1116 SCREWS (4 REQ'D)
174916 SPACER
96550 "O" RING (2 REQ'D)

TWO STAGE SERVO CONTROL

(4 REQ'D)
"O" RING
981 PLUG
"O" RING
37982 CAP
074 PLUG
240 SPRING
7238 VALVE
7076 PLUG
223204 NUT (4 REQ'D)
TORQUE TO 520 ± 10 lb. in.
7075 PLUG

214632 SCREW (4 REQ'D)
SC4-03-***-**
SINGLE STAGE SERVO VALVE

117671 SEAT
117670 PISTON
239301 SPRING
113416 GUIDE
153999 "O" RING
238607 RETAINER
154004 "O" RING
238606 PLUNGER
138881 RETAINER
1487 NUT
130730 ADJUSTMENT SCREW

SINGLE STAGE SERVO CONTROL

■FOR INSTALLATION OF ANTI-BACKLASH GEAR INTO PUMP, REFER TO FIGURE NO. 7 OF MAINT. MANUAL I-3201-S.

NOTE
RELIEF VALVE AND SERVO VALVE PARTS INFORMATION IS SHOWN IN THE FOLLOWING PARTS DRAWINGS:

I-3060-S	● SA4-03-**-***-10, 11, 12, 13, 14
I-1880-S	△ SC4-03-***-10
I-3061-S	△ SC4-03-***-12
I-1585-S	● CG-03-**-10

○INCLUDED IN 941192 SYNCHRO KIT

*INCLUDED IN 941894 POTENTIOMETER KIT

CONTROL MODEL	SERVO VALVE		TYPE OF FEEDBACK CONTROL	FEEDBACK CONTROL KIT
	MODEL	ASSY #		
CAM-SR7-10/11	SC4-03-530-20	252918	POTENTIOMETER	941894
CAM-SRA7-10/11/12	SC4-03-220-20	252917		
CAM-SRC7-11/12	SC4-03-004-20	283824		
CAM-SS7-10/11/12	SC4-03-530-20	252918	SYNCHRO	941192
CAP-DR7-10/11/12	SC4-03-530-20	252918	POTENTIOMETER	941894
CAP-DRA7-10/11/12	SC4-03-220-20	252917		
CAP-DRB7-10/11	SA4-03-**-***	———		
CAP-DS7-10/11/12	SC4-03-530-20	252918	SYNCHRO	941192
CAP-SR7-10/11/12	SC4-03-530-20	252918	POTENTIOMETER	941894
CAP-SRA7-10/11/12	SC4-03-220-20	252917		
CAP-SRC7-11/12	SC4-03-004-20	283824		
CAP-SS7-10/11	SC4-03-530-20	252918	SYNCHRO	941192

POTENTIOMETER CENTERING PROCEDURE

The following procedure is suggested to center the potentiometer:

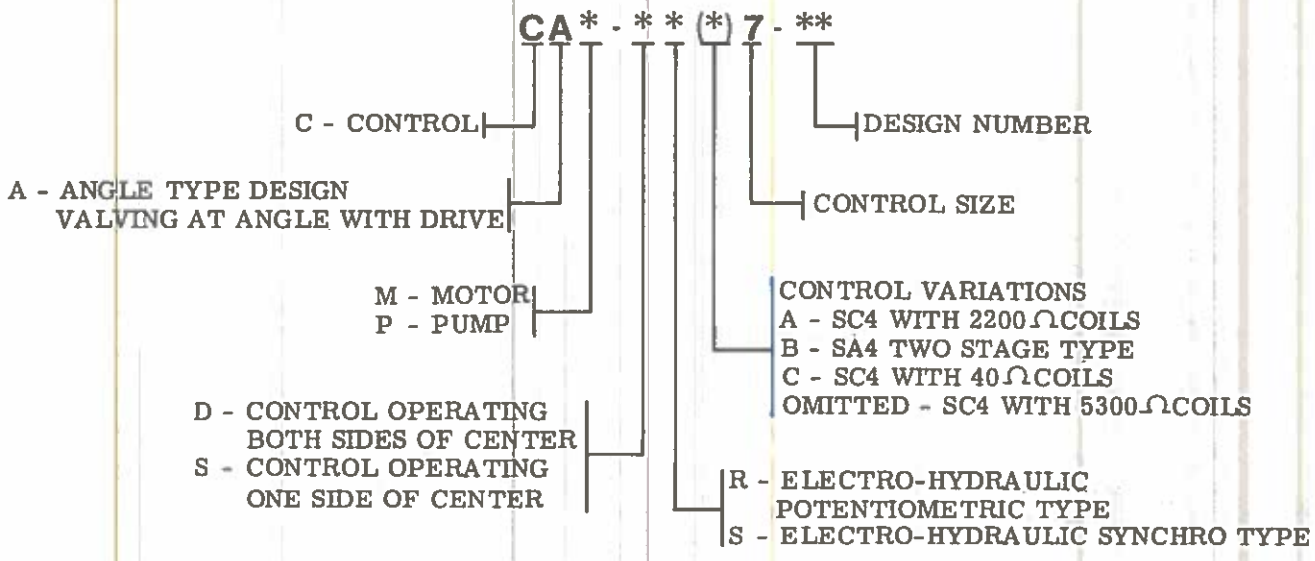
1. Place the yoke in the 30^{o} down position.
2. Remove cover and loosen potentiometer clamps 235061.

CAUTION

In the following step, select a high range on the Ohmmeter to limit current through the potentiometer, when making a resistance measurement. Current through the potentiometer must not exceed 0.010, (10 milliAmperes), or damage may result.

3. Measure resistance between pins A and C on connector 118404.
4. Rotate potentiometer until a resistance reading of 8070 Ohms is obtained.
5. Tighten clamps without disturbing resistance setting.

MODEL CODE BREAKDOWN


CA* - * * (*) 7 - **
C - CONTROL
DESIGN NUMBER
A - ANGLE TYPE DESIGN
VALVING AT ANGLE WITH DRIVE
CONTROL SIZE
M - MOTOR
P - PUMP
CONTROL VARIATIONS
A - SC4 WITH 2200Ω COILS
B - SA4 TWO STAGE TYPE
C - SC4 WITH 40Ω COILS
OMITTED - SC4 WITH 5300Ω COILS
D - CONTROL OPERATING
BOTH SIDES OF CENTER
S - CONTROL OPERATING
ONE SIDE OF CENTER
R - ELECTRO-HYDRAULIC
POTENTIOMETRIC TYPE
S - ELECTRO-HYDRAULIC SYNCHRO TYPE

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

PISTON PUMPS

MODEL SERIES PVA120/150

VARIABLE DISPLACEMENT ANGLE TYPE

GENERAL DATA
Pumps are of angle-type, variable displacement, axial piston design. The PVA120 will produce flows to 180 GPM at 1800 RPM and has pressure ratings to 5000 PSI maximum. The PVA150 output is 150 GPM at 1200 RPM and pressures up to 3000 PSI.

The electrohydraulic control provides precise pump displacement control for electrical remote control. See drawing 509400 for the hydro-mechanical control; 509500 for the pressure compensator; and 509600 for the handwheel.

INSTALLATION
A full size unrestricted drain line (1.50 O.D. tube or equivalent) must be connected directly from the case drain connection to a location below the lowest fluid level in the system reservoir. Pressure surges at the case drain connection on pump should not exceed 20 PSI.

RATINGS
See chart for operating specifications.

Circuit must provide for circulation of cool oil through pump case from bottom to top drain connection.

PVA120 Series:
1200 RPM - Circulate 3 GPM
1800 RPM - Circulate 5 GPM

PVA150 Series:
1200 RPM - Circulate 3 GPM

Case pressure of 10 PSI ± 5 must be maintained when operating at speeds above 1200 RPM. If necessary, 5 or 10 PSI check valve may be used in the case-cooling oil circuit to obtain case pressure.

Input Horsepower
Approximate input horsepower required =

$$\frac{\text{Flow} \times \text{Pressure}}{1714} \times \frac{1}{\text{Overall Efficiency}} + \text{Aux. Pump Input Hp}$$

(Actual horsepower input required depends on duty cycle.)

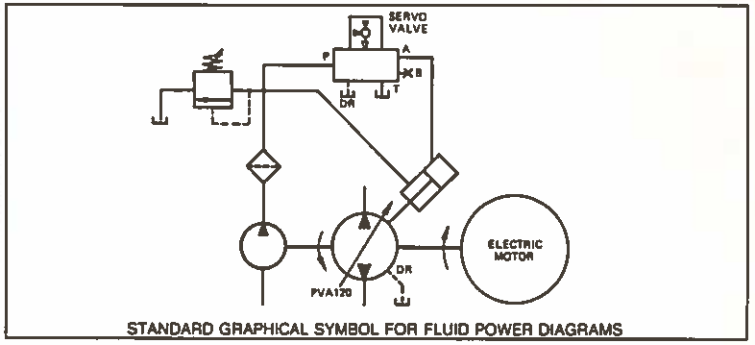
Starting
Before start-up fill pump case with system fluid through case drain connection. (Use airbleed provided.) Case must remain full of fluid to provide internal lubrication. (Avoid siphoning action.)

Shaft Rotation
Either clockwise or counter-clockwise rotation is available. Indicate rotation when ordering.

OPERATING SPECIFICATIONS

Model No.	Theo-retical Max. Disp. Cu. In./ Rev.	GPM Delivery		Drive Speed RPM*		Pressure PSI		Vol. Eff. at Max. Disp., Max. PSI & Rated RPM	Overall Eff. at Max. Disp., Max. PSI & Rated RPM
		Rated	Max.	Rated	Max.	Rated	Max.		
PVA120	23.71	120	180	1200	1800	3000	5000	96%	94%
PVA150	28.96	150	150	1200	1200	2500	3000		

* Vickers engineering approval is required for all applications with speeds above 1200 RPM.



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

MODEL CODE

P V A 120 - RS - 13

[1] [2] [3] [4] [5] [6]

[1] Pump

[2] Variable Displacement

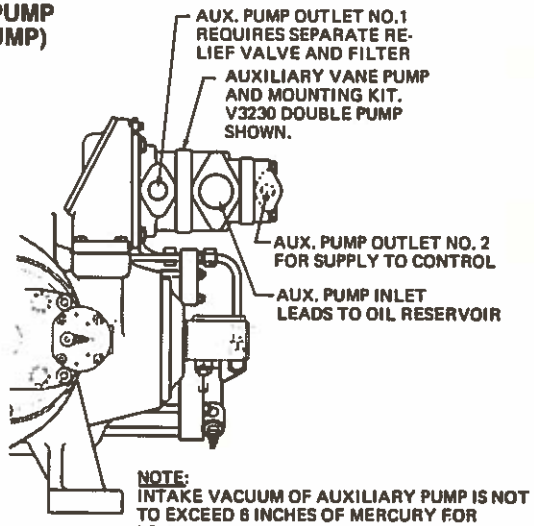
[3] Angle Type

[4] Capacity Rating
120 - 120 GPM
150 - 150 GPM

[5] Rotation
(viewed from shaft end)
R - Right hand (CW)
L - Left hand (CCW)

[6] Design Number
Subject to change. Installation dimensions remain as shown for designs numbers 10 through 19.

AUXILIARY PUMP (DOUBLE PUMP)


AUX. PUMP OUTLET NO.1 REQUIRES SEPARATE RELIEF VALVE AND FILTER
AUXILIARY VANE PUMP AND MOUNTING KIT. V3230 DOUBLE PUMP SHOWN.
AUX. PUMP OUTLET NO. 2 FOR SUPPLY TO CONTROL
AUX. PUMP INLET LEADS TO OIL RESERVOIR

NOTE:
INTAKE VACUUM OF AUXILIARY PUMP IS NOT TO EXCEED 6 INCHES OF MERCURY FOR PETROLEUM OIL.

PUMP INLET AND OUTLET PORTS

If system pressure is imposed on the pump inlet and outlet ports at the same time, even for a short duration, pump should probably have a motor valve plate. Contact Vickers application engineer for assistance.

Inlet Conditions

For applications over 1200 RPM, for synthetic fire resistant fluids, (with engineering review and comments), or cross center applications, 100 PSI supercharge pressure is preferred. Note that inlet pressure reduces sound. (See chart.)

Minimum Outlet Pressure

A minimum pressure of 150 PSI at the pump outlet is recommended.

Absolute Minimum Pressure at Pump Inlet					
Model	One Side of Center		Cross Center		*Synthetic Fire Resistant Fluids
PVA120	1200 RPM	To 1800 RPM	1200 RPM	To 1800 RPM	1200 RPM Only
	4" Hg	50 PSI	25 PSI	75 PSI	100 PSI
PVA150	4" Hg	Not Approved	25 PSI	Not Approved	100 PSI

* Commonly used industrial synthetic fire resistant fluids only. No water glycol, water-in-oil emulsion or soluble oil-in-water solutions. (Air pressurization of reservoir is not to be used.)

AUXILIARY PUMPS

To supply hydraulic power for the electrohydraulic control, or other purposes, PVA series pumps provide for an optional auxiliary pump. These are mounted on the housing and driven by an internal 1:1 drive from the main pump shaft. Either single or double vane pumps may be specified. Pumps and mounting kits are as tabulated.

FILTRATION

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/12 or cleaner. Selections from Vickers OFP, OFR and OFRS series are recommended. Refer to Section "P"-"Filters" and Section "S"-"Technical Information" of Vickers Catalog 400, or contact your Vickers representative for further filtration advice.

FLUIDS AND TEMPERATURE DATA

Select antiwear type industrial hydraulic oils or automotive crankcase oils with a nominal viscosity of 215 to 315 SUS at 100°F and having letter designation "SC, SD, or SE" per SAE technical report J183a. Operating viscosity range is 70 to 250 SUS. Operating temperature of 120°F typical to 180°F maximum is recommended.

Refer to Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400) for additional information.

Auxiliary Pumps Available †				
Model	GPM Approx. at 1200 RPM		Mounting Kit	Installation Drawing
	Shaft End	Head End		
Single Pumps V210-••-1A-12-S214-LH	2-5-6-8W-9W-11W		293265	I-236693
Double Pumps V2230-•••-1CA-20-S214-LH	2-5-6-8W-9W-11W	2-5-6-8W-9W-11W	293266	I-248700

Note:
1. Auxiliary pump's rotation is opposite that of main pump — add "LH" suffix to auxiliary pump only for PVA•••-R models.
†2. Horsepower input to the auxiliary pump is limited to 10 HP at 1200 RPM and 15 HP at 1800 RPM.
3. When an auxiliary pump is specified, the outlet of the smallest pumping element will normally be connected to the control system. See next page for flow and pressure.
4. Inlet connection and intake strainer should be provided for the auxiliary pump. Drawing 500800 (on T10 power units) and drawing 522150 (on intake filters) will provide general information. Specific requirements depend on auxiliary pump selected.

APPLICATION GUIDANCE

These units are designed to meet specifications as outlined. To insure maximum unit performance, in conjunction with your specific application, consult your Vickers application engineer if your:

- Pressure requirements are above rated pressures.
- Speed is above rated RPM.
- Cycle requires control to shift pump yoke full stroke in less than three seconds.
- System requires fire resistant fluid.
- Operating temperature is not within 100°F to 150°F. (With proper application and fluid consideration, a greater temperature range is permissible.)
- Oil viscosity at operating temperature is not within 100 to 250 SSU.
- Oil viscosity at start-up is in excess of 1000 SSU.
- Application requires an indirect drive.
- Needs require application assistance.
- Mounting is other than horizontal.

WEIGHT

Pump and Control .... 1150 lbs.

SERVICE INFORMATION

Refer to specific Vickers part drawing or overhaul manual for service information. A complete "Index to Industrial Products Service Information" is included in the Technical Information section of Vickers Catalog 400.

HOW TO ORDER

Pump

See model code, page 1.

Control

See chart, page 3.

System Flanges

Inlet and outlet flanges of the ell-welding neck type, 3-1/2 inch pipe size (nominal) are available. Model number FL2-120-28BWL-10 (two required) is shown on drawing 522910.

S-569 Feature

This feature is available single side of center only. When the "S-569" pump is mounted horizontally as shown (page 1), the yoke operation is in the upper quadrant. This "S-569" must be indicated on the order in both the model number for the pump and the control. (Example below on how to order.) Under above duty conditions, the "S-569" feature permits the pump yoke to settle to the zero displacement position (center) when pump and control power are off. With the pump yoke in the center position and control set for no flow, starting is simplified. The pump outlet need not be bypassed to tank while control power system is being started.

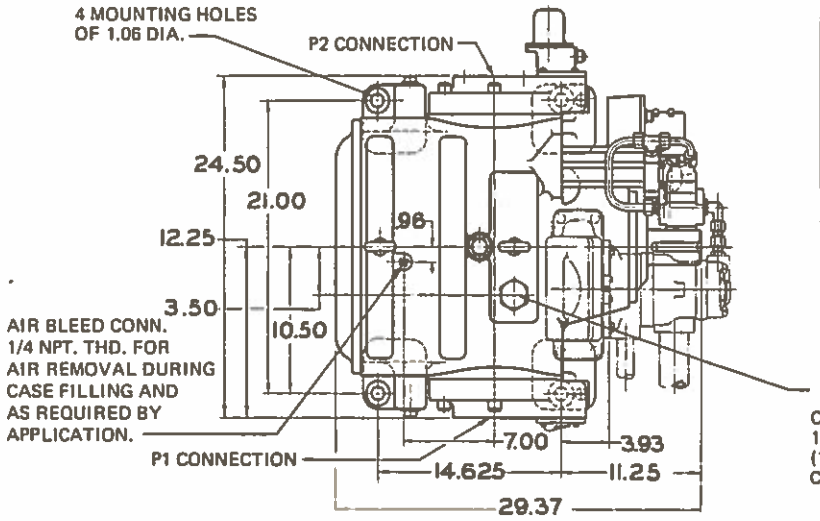
Example of Order: CAP-SRC7-11-S569

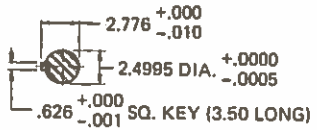
One (1) PVA 150 pump assembly including:
- One (1) PVA150-LS-13-S569
- One (1) CAP-SRC7-11-S569
- One (1) V3230-15-5-1C-12-S214
- One (1) 293264 Mounting Kit
- Two (2) FL2-120-28BWL-10 Flanges

CONTROL

All Controls	Used on	Stroke Condition	Type	Single and Two Stage Servo Valves	Size	Design No.
CA	P (Pump)	D (Both Sides Center or S (-One Side of Center) Pump Yoke Down	R (Electrohydraulic with Potentiometer Yoke Feedback)	SC4-03 "C"= *40 Ohms SA4-03 "B" ▲	7	-11
Example: CAP -SRC7-11						

* Other resistance coils are available. Consult Vickers application engineer.
▲ "B" – SA4-03 servo valve must be ordered separately. Specify linkage and torque motor coil resistance.

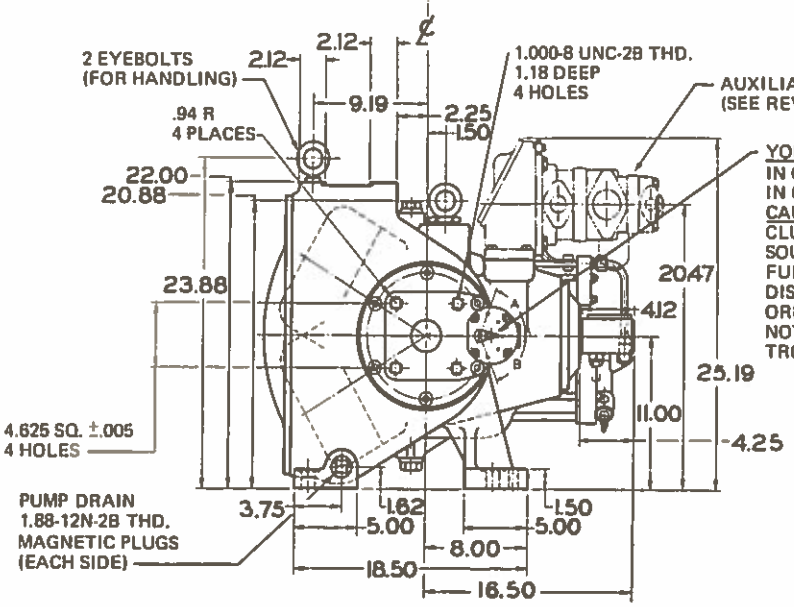




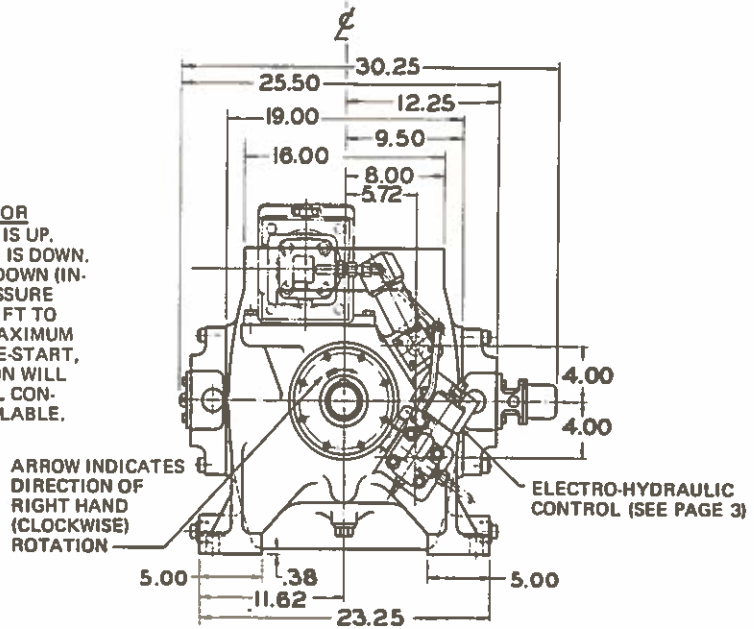
SECTION THROUGH SHAFT

CASE DRAIN CONNECTION
1-7/8 - 12N-2B THD.
(1-1/2 O.D. TUBING – MINIMUM SIZE)
CONNECT DIRECTLY TO TANK

SHAFT ROTATION	YOKE POSITION	OUTLET PORT	INLET PORT
CLOCKWISE	UP	P1	P2
	DOWN	P2	P1
COUNTER-CLOCKWISE	UP	P2	P1
	DOWN	P1	P2



YOKE POSITION INDICATOR
IN QUADRANT "A" YOKE IS UP.
IN QUADRANT "B" YOKE IS DOWN.
CAUTION: AFTER SHUT-DOWN (INCLUDING CONTROL PRESSURE SOURCE) YOKE WILL DRIFT TO FULL DOWN POSITION MAXIMUM DISPLACEMENT. UPON RE-START, ORIGINAL YOKE POSITION WILL NOT BE ATTAINED UNTIL CONTROL PRESSURE IS AVAILABLE.



I-509300-3

ELECTROHYDRAULIC CONTROL

The electrohydraulic control provides instant response from an electrical input signal and accurately controls displacement through full pump range. The CAP-*R*7-10 control includes all the necessary features to provide either fast acting electrical remote control of pump displacement, or a high response servo pump for use in a closed loop electrohydraulic servo system.

The electroyhydraulic control requires a continuous supply to the pump displacement control. This can be provided for by the auxiliary vane pump. A separate control pump should also be considered. This permits activating the control system and positioning the PVA pump yoke before starting. It also simplifies checkout of the servo controls without operating the main system. The control filter (not auxiliary pump intake filter), control pressure relief valve, and connecting tubing are included as part of the control, and are assembled on the unit.

A theoretical flow of 2.5 GPM from auxiliary source will stroke unit from 30°-30° in one second. Actual stroking speed is governed by the flow capacity of servo valve used. With SC4 series (single stage) yoke, stroking speeds to approximately 3 seconds for full reversal (30°-30°) can be attained. With use of the SA4 (two stage), speeds to .5 seconds can be attained for full reversal (30°-30°).

Additional specifications on the SC4 or SA4 series servo valve used on this control can be obtained from drawing 519500 or 501500.

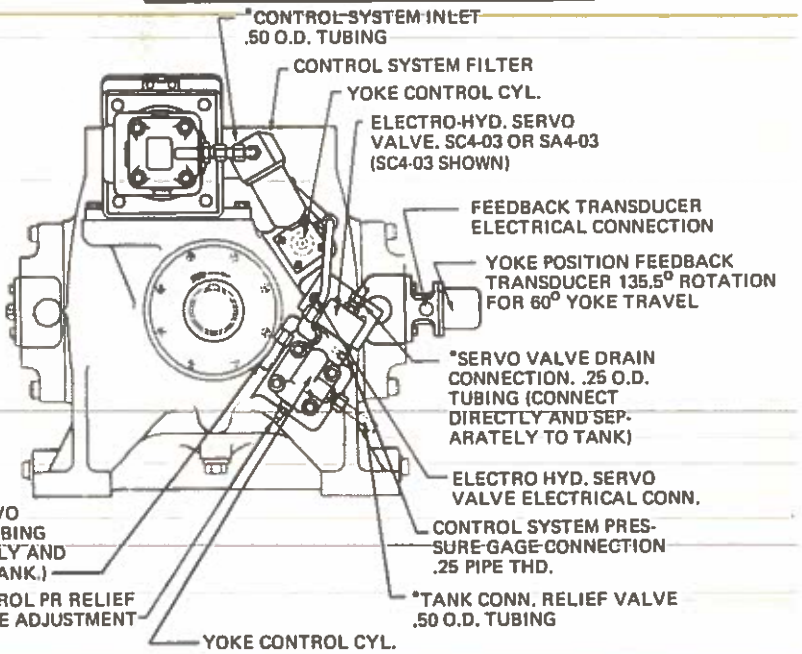
Maximum control flow through relief valve .....5 GPM

Control pressure range ..... 350 to 1000 PSI

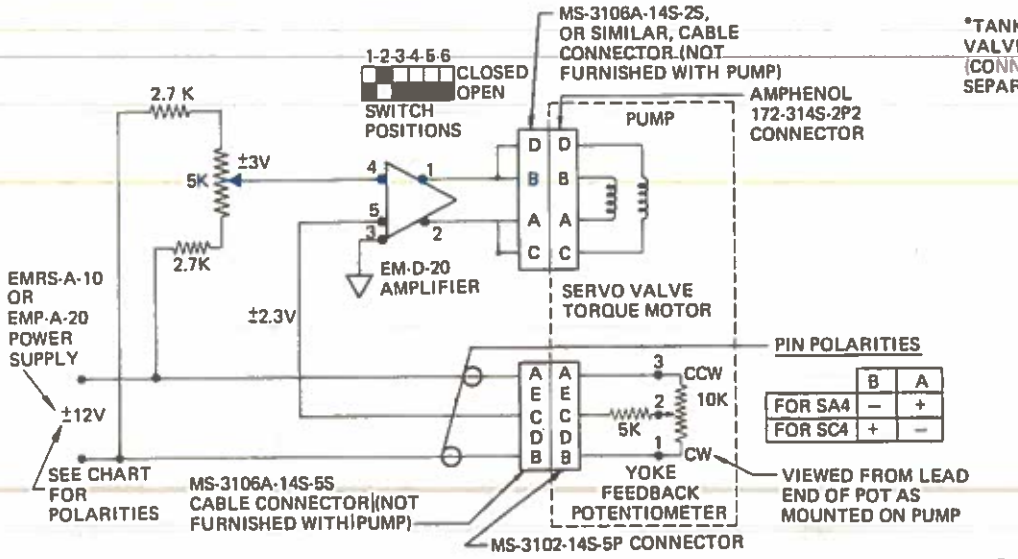
Factory adjusted to .....750 PSI

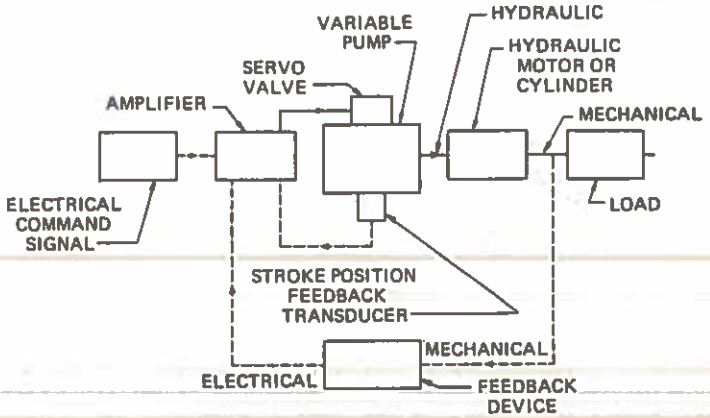
***CAUTION**

THE FLOW FROM THE PVA PUMPS SHOULD BE RETURNED TO TANK AT START-UP UNTIL PRESSURE IS AVAILABLE AT THE CONTROL SYSTEM INLET.


*CONTROL SYSTEM INLET .50 O.D. TUBING
CONTROL SYSTEM FILTER
YOKE CONTROL CYL.
ELECTRO-HYD. SERVO VALVE. SC4-03 OR SA4-03 (SC4-03 SHOWN)
FEEDBACK TRANSDUCER ELECTRICAL CONNECTION
YOKE POSITION FEEDBACK TRANSDUCER 135.5° ROTATION FOR 60° YOKE TRAVEL
*SERVO VALVE DRAIN CONNECTION. .25 O.D. TUBING (CONNECT DIRECTLY AND SEPARATELY TO TANK)
ELECTRO HYD. SERVO VALVE ELECTRICAL CONN.
CONTROL SYSTEM PRESSURE GAGE CONNECTION .25 PIPE THD.
*TANK CONN. RELIEF VALVE .50 O.D. TUBING
*TANK CONN. SERVO VALVE. .50 O.D. TUBING (CONNECT DIRECTLY AND SEPARATELY TO TANK.)
CONTROL PR RELIEF VALVE ADJUSTMENT
YOKE CONTROL CYL.

*FOR DRAIN CONNECTIONS WHEN USING SA4-03 SERVO VALVE, REQUEST INSTALLATION DRAWING 501500. THE PILOT PRESSURE IS INTERNAL FROM THE SA4 PRESSURE LINE.





TERM. 4 IN RESPECT TO 3
TERM. 1 IN RESPECT TO 2

COMMAND	VICKERS TORQUE MOTOR POLARITY		VICKERS PORT LINE UP		PUMP YOKE FDBK ROT	YOKE POS. QUADRANT	OUTLET PORT: CROSS CENTER RH ROT	OUTLET PORT: CROSS CENTER LH ROT	OUTLET PORT: SINGLE SIDE RH ROT	OUTLET PORT: SINGLE SIDE LH ROT
+	+	–	P - A	–	CW	A (UP)	P1	P2	P1	P2
–	–	+	–	A - T	CCW	B (DN)	P2	P1	CENTER	CENTER
	SA4	SC4								

FIGURE NO. 2. BLOCK DIAGRAM OF TYPICAL SERVO PUMP CONTROL CIRCUIT. BROKEN LINES SHOW POSSIBLE FEEDBACK LOOPS.

I-509300-4

SERVO PUMPS

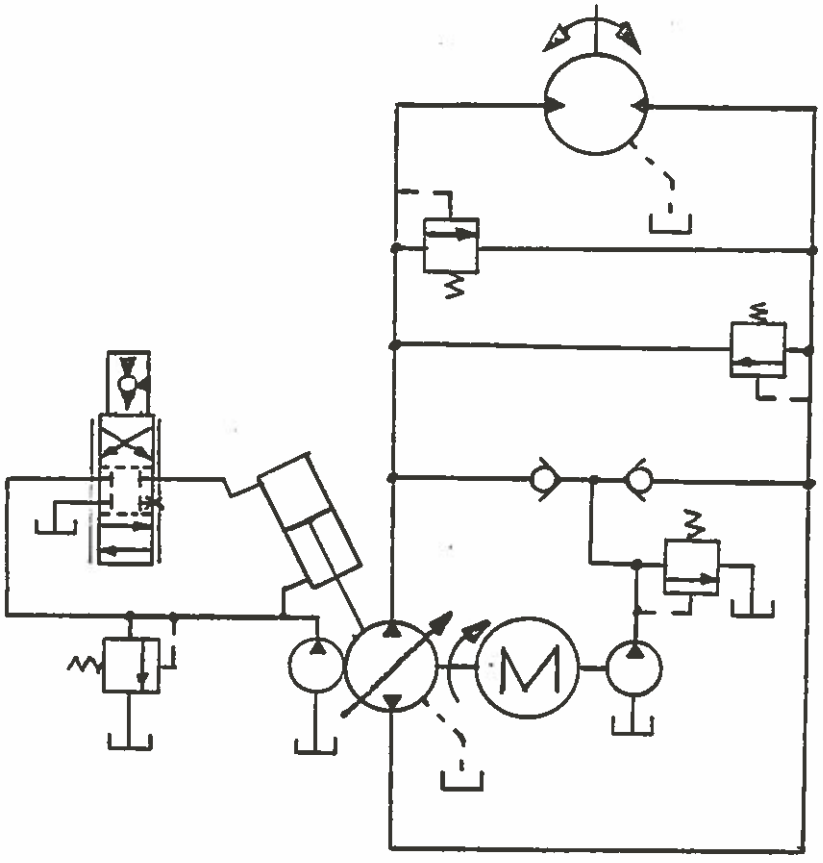
INTRODUCTION:

Where high flow and horsepower are required, a servo pump system is generally used. This is primarily because of its higher efficiency in comparison to a servo valve system from a heat loss standpoint.

The main purpose, however, of this portion of the course will be to acquaint the student with the physical hardware.

DESCRIPTION OF A TYPICAL SERVO PUMP CIRCUIT

This type of circuit uses a servo valve to position a control cylinder on a variable delivery pump. The pump output in turn will then control the speed and direction of rotation of a hydraulic motor. Here the pump supplies only the amount of flow required by the load.

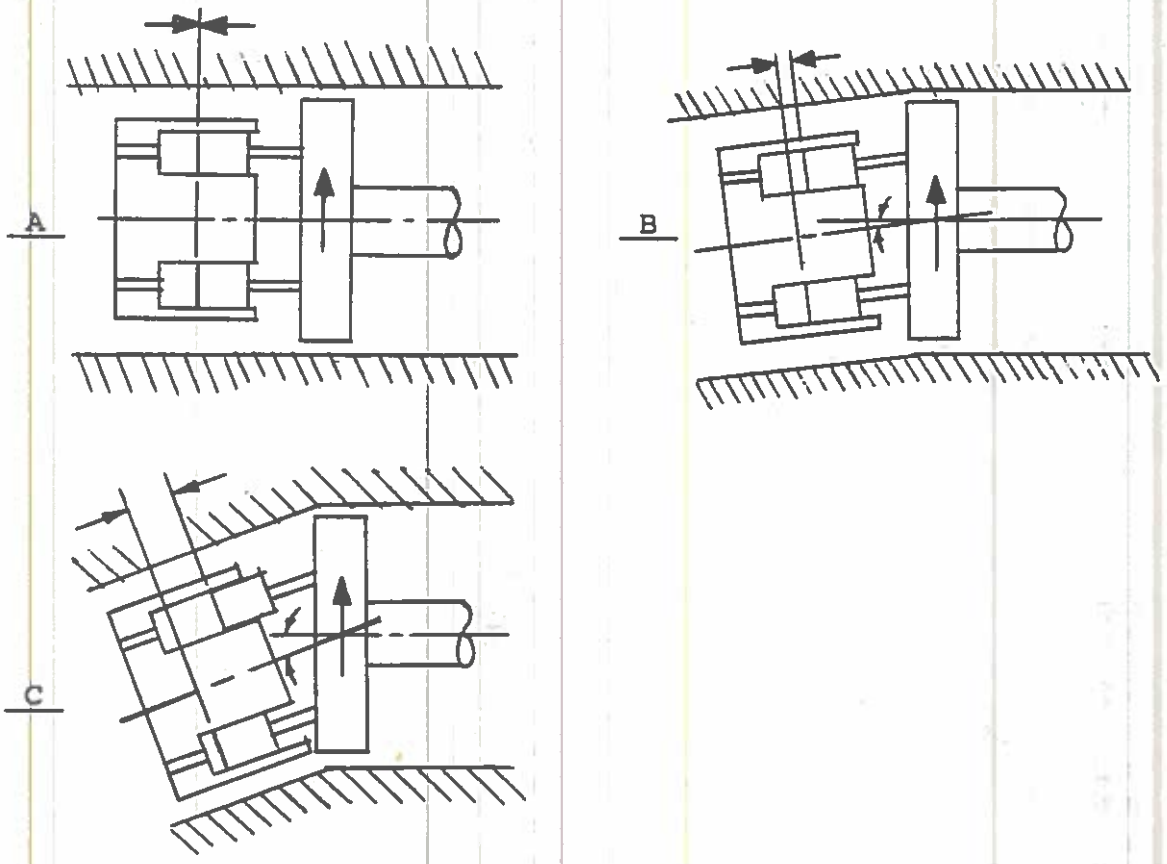


SERVO PUMP DESCRIPTION

The servo pump is a variable displacement type unit with a uni-directional or bi-directional output. The two basic types of pumps used are the axial and radial piston units. We will, however, discuss just the axial type, which can be of the bent axis or in-line design.

1. BENT AXIS VARIABLE DISPLACEMENT TYPE PUMP

In this pump the cylinder block is housed in a yoke which can be positioned at various angles. Pump output is determined by the yoke position (cylinder block axis) relative to the drive shaft axis. (See Figures A, B, and C below.)

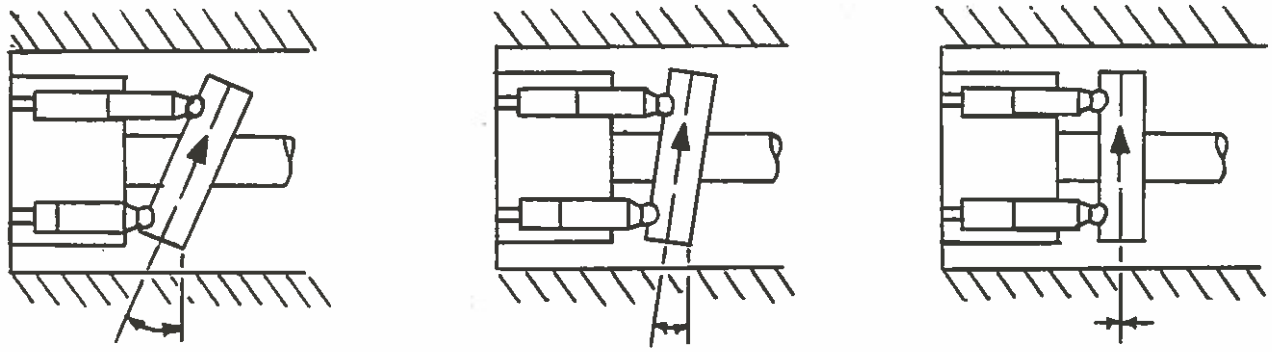


Also refer to Chapter 11, Page 28, of the Vickers Industrial Manual #935100-A for more detailed drawings.

This type of pump is available in various sizes with flows ranging from 0 to 500 GPM. Maximum allowable pressures will vary with pump size, physical construction, and application, and may be as high as 5000 PSI.

2. IN-LINE VARIABLE DISPLACEMENT PUMP

The operation of this pump is similar to the bent axis design. The main difference being that the cylinder block and pistons remain parallel to the drive shaft axis. The displacement of a given size pump is determined by the stroke of pistons; which in the in-line design is accomplished by varying the angle of a swash plate. The swash plate is contained in a yoke which is allowed to pivot under the influence of a yoke actuator. (See drawings below)



This type of pump is available in various sizes with flows ranging from 0 to 200 GPM. Maximum allowable pressures may be as high as 5000 PSI depending on size and application of a particular unit. For further information and reference, see Chapter 11, Page 25, of the Vickers Industrial Hydraulics Manual #935100-A.

HYDRAULIC POWER UNITS FOR SERVO SYSTEMS

In planning a servo system, our first concerns are with selecting the proper sizes for the actuator, valve and electrical control elements. Our work is not completed, though, until we have made provision for a hydraulic power unit which will supply clean, cool oil to the servo valve at the proper flow and pressure levels. There are almost as many designs of hydraulic power units for this purpose as there are uses of servo valves. However, there are some guide lines that can be followed. We will try to cover these and also show some of the variations that have been used to fit particular needs.

POWER UNIT PHOTO

The first slide shows a picture of a basic power unit consisting of a tank, a pump, an electric motor, a relief valve, and a pressure line micronic filter. Hot oil returning from the servo valve moves slowly in the tank. This slow movement gives the oil time to cool, and also allows any sediment that may be present, time to settle out. Generally, there is a baffle inside the tank. Sometimes there is a pump inlet strainer in the tank. If not, there will be a "tell-tale" type strainer on top of the tank. The tell-tale units provide maintenance personnel with a visual indication of the condition of the strainer element and can provide a warning when a change is necessary.

SC4-03

The hydraulic power unit as shown in the slide could be used directly in a positioning system using the single stage servo valve. FIGURE 1 shows the circuit diagram of the arrangement.

System pressure is limited to 1000PSI and flow to 3-3/4 gpm.

When the cylinder is at a position, the full flow of the pump passes over the relief valve and the pressure of the system is the setting of the relief valve. When the system is commanded to a new position, the servo valve opens up wide and the oil from the pump is now directed through it to the cylinder. System pressure now is the sum of the pressures required to move the load and the pressure drop in the servo valve. It could be well below the relief valve setting if the load is small. On the other hand, if the load pressure is quite high, there may not be enough system pressure available to put full pump delivery through the valve. In this case, the flow then divides between the servo valve and the relief valve and the cylinder moves slower than what might otherwise be expected.

MORE THAN 3 GPM

If more than 3 GPM is required, the two stage servo valve must be used. Here separate control pressure and supply pressure lines are required and separate filters are used as shown by the dashed lines in FIGURE 1. If the load requires a relatively large pressure to be moved, system pressure will always be at the relief

valve setting or at a fairly high level. The control pressure then will always keep the servo valve under control. However, if system pressure can drop to a low value during the time the cylinder moves, the servo valve may become erratic or operate improperly.

SEPARATE CONTROL PRESSURE SOURCES - 2 PUMPS

To avoid this difficulty, the control pressure can be obtained from a separate source. FIGURE 2 shows one possible arrangement using a double shaft motor with a large pump on one end to provide the proper amount of oil for the cylinder and a small pump on the other end to provide oil for the control circuit of the servo vlave.

SEPARATE CONTROL PRESSURE SOURCES - DOUBLE PUMP

Double shaft extension motors are a little more expensive and of course added cost results when an extra pump must be mounted on a tank, both for the hardware and for the extra size of the tank. Often time it is more economical to use a double pump as shown in FIGURE 3. Here two pump sections built into one housing are driven by a single shaft. The double pump unit can then be driven by a standard electric motor. We have four different types of double pumps to choose from -- VC, double round, double square, and VHO. The following slides illustrate each type.

SYSTEM PRESSURE ABOVE 1000 PSI

If the system pressure exceeds 1000 PSI, the two stage servo valve must be used, regardless of flow requirements. However, the control pressure to this valve must not exceed 1000 PSI. To meet

these requirements, two separate pumps of the proper pressure and flow ratings driven by a double shaft motor, or a high pressure double pump in the circuit of FIGURE 3 could be used. Another arrangement is shown in FIGURE 4. Here a single high pressure, high volume pump is used. The flow is directed to the servo valve and also to a branch circuit containing a pressure reducing valve. The reducing valve should be set so that the pressure applied to the pilot stage of the servo valve will not exceed a safe working level of 1000 PSI. It also tends to smooth out system pressure variations that might occur in the main section of the circuit.

HEAT

In all of the circuits that we have discussed, heat is produced in the oil whenever oil flows over the relief valve. Some heat is also generated when oil flows through the servo valve because of the pressure drop that occurs there. If the pressure level or the flow rate or both are large, and if they occur for any period of time, the amount of heat generated in the oil may become prohibitive. High temperatures in the oil cause reduction in the oil viscosity, increase leakage, cause the servo valve to change its characteristics and can damage the oil. The amount of heat produced in a servo system must always be checked and means provided to take care of it.

STOPPING POWER UNIT OR VENTING PUMP

One thing that can be done to protect the oil from excessive heat is to operate the electric motor only when the system is re-

quired to move the load from one point to the next. This usually is awkward. A better way is to unload the system by venting the supply pressure relief valve. Unless the system is relatively small, it will probably be necessary to add a heat exchanger so that the hot oil coming from the relief valve can be cooled before being returnid to the tank. Automatic temperature controls can be provided on the tank unit so that the oil temperature can be held at a uniform value. This is desirable in applications where repeatability and high degree of accuracy are important. FIGURE 5 shows both the relief valve venting and heat exchanger components added to one of the circuit sketches.

PRESSURE COMPENSATED PUMPS

Another method of keeping heat losses down is to use a pressure conpensated variable delivery pump. FIGURE 6 shows a circuit diagram using one of these pumps. This unit supplies whatever amount of oil may be required by the circuit at the pressure setting of the compensator. It is good practice to use a high pressure safety valve with some of the larger pumps.

The smaller size pumps respond to changes in flow requirements very quickly and pressure transients due to instantaneous changes in servo valve settings are relatively small. In some cases, however, the pump response may be slow enough that another source of oil may be needed temporarily to maintain system pressure. This can be obtained with an accumulator which stores a volume of oil under pressure and makes it available whenever system pressure starts to drop. This arrangement has considerable

appeal in the higher horsepower applications because the electric motor delivers only the amount of power that the system requires. When the cylinder is stationery, the pump flow is virtually zero, the power drawn from the electric motor is virtually zero, the heating of the oil is low, and overall system efficiency is high.

MORE THAN ONE VALVE ON A MACHINE

When there is more than one servo valve on a machine, it is usually desirable from the cost standpoint to operate them from the same hydraulic power unit. If two valves are to be used, the simplest arrangement would use a double shaft extension motor with a single or double pump at each end depending upon the type of valve used. This provides complete circuit isolation and is the ideal arrangement. Another combination that can be used to advantage where two and especially where more than two valves are used is shown in FIGURE 7. Here a pressure compensated pump is used for the supply pressure sections of all valves and a separate fixed displacement pump is used for the control pressure lines of all pumps. Efficiency is good with this arrangement and the heat dissipation problems are minimized.

ELIMINATING LURCHING AT START UP

The second stage spool of the servo valve might drift to any position while the system is turned off. At start up oil might be ported to either cylinder port "A" or port "B" until the control pressure brings the valve under control. This can sometimes

Cause a small lurch or jump in the actuator at start up. One way to avoid this is to assure that the control pressure is applied to the valve first. Separate pumps driven by separate motors would be the one way of doing this. A more convenient way would be to use a sequence valve as shown in FIGURE 8. Here no oil reaches the supply circuit until the control pressure circuit is up to operating presuure.

VELOCITY SYSTEMS

Cylinder positioning type systems have been shown in all of the examples thus far. Hydraulic motors could have been used equally well in place of the cylinders. Motors are also used in velocity systems. Here they may be required to run at long intervals with continuous flow from the power unit at full system pressure. Either a pressure compensated pump or a fixed displacement pump with a heat exchanger must be used in a velocity system. Sometimes a small heat exchanger will be needed even with a pressure compensated pump.

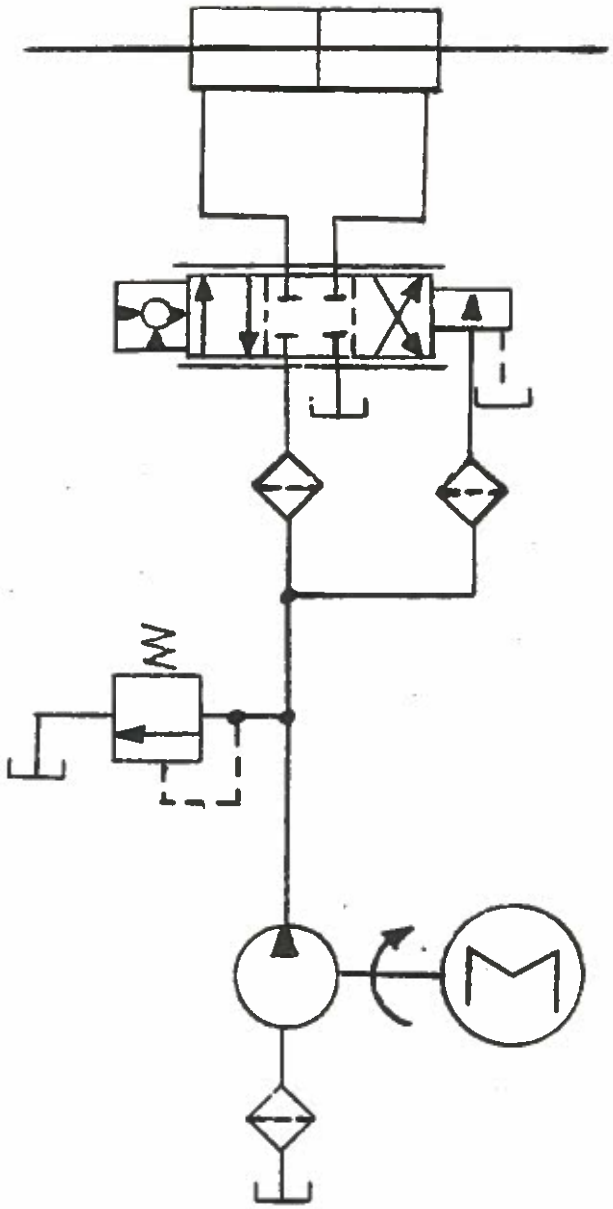
SEPARATE POWER UNIT FOR USE WITH SERVO PUMPS

The servo valve on a servo pump must be furnished with a source of oil. While there is a temptation to drive this control pressure pump with the same motor that drives the servo pump, it is generally best practice to use a separate power unit entirely. This allows the pump displacement control circuit to be started first and assure that the pump stroking mechanism is under proper control before the main power system is turned on.

This power unit can be small, inexpensive, and located at any convenient point.

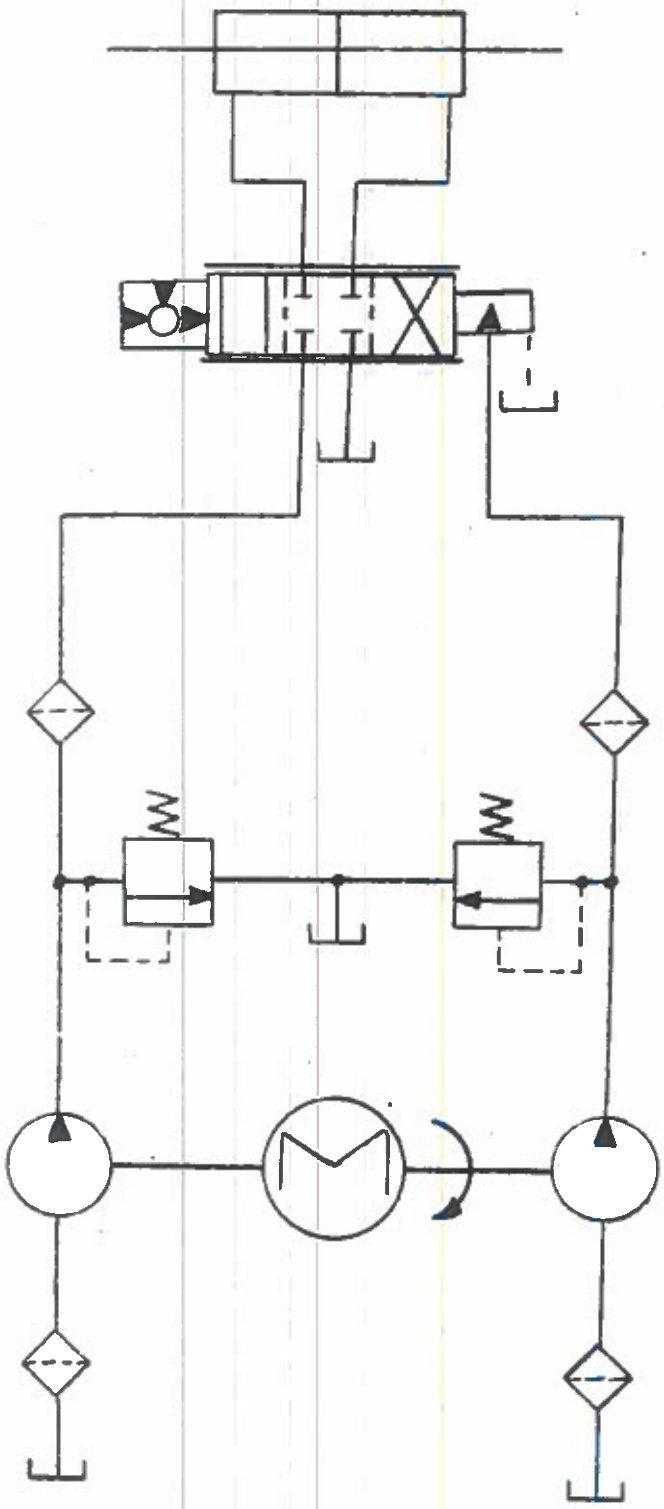
CONCLUSION

This discussion has suggested some of the things that should be kept in mind when planning a hydraulic power unit for a servo system. The power unit is the largest single item in the system, it represents a fair percentage of the total cost, and its performance has a direct influence on how well the system operates. Best total servo system performance will be obtained when the power unit delivers oil to the servo valve responsively, at a uniform temperature, and as free as possible from pressure changes and pulses.



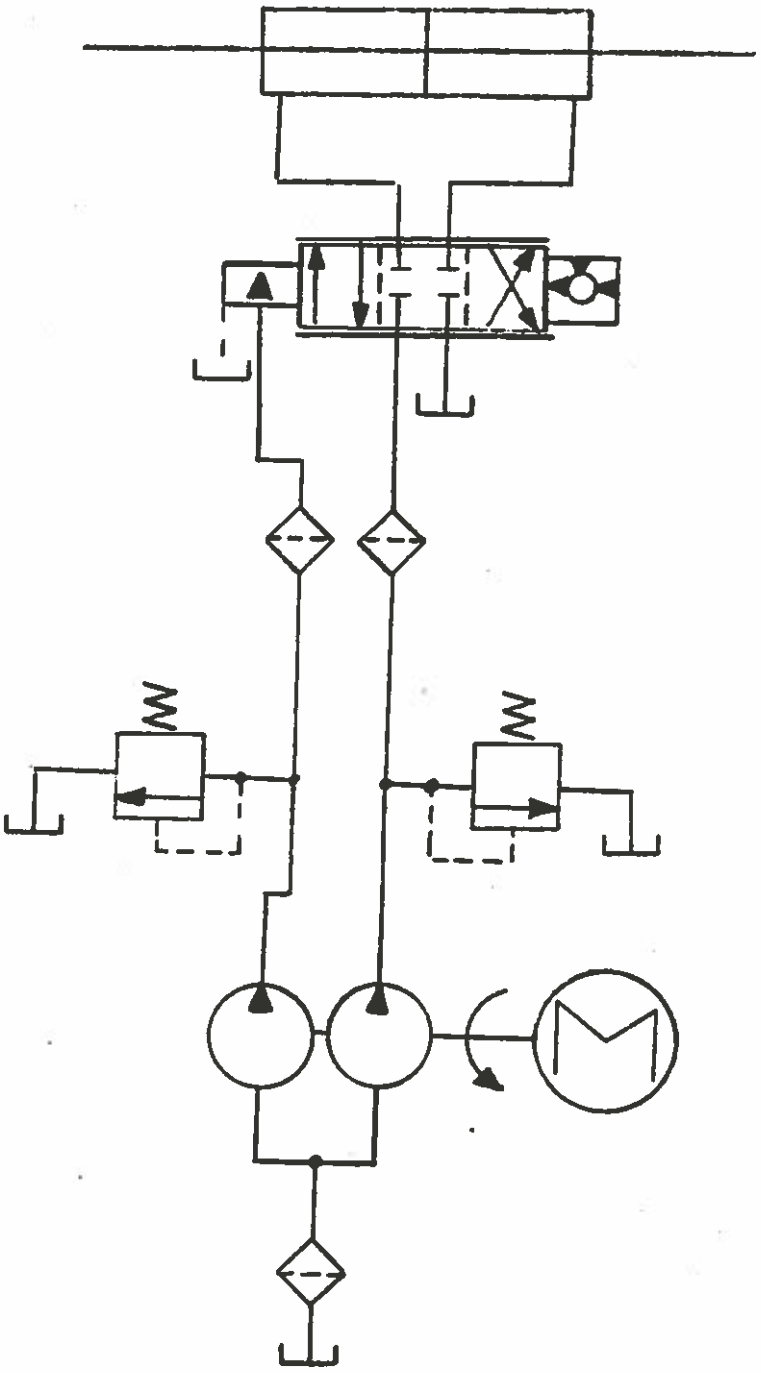
Basic circuit
single and two
stage valves

Figure 1



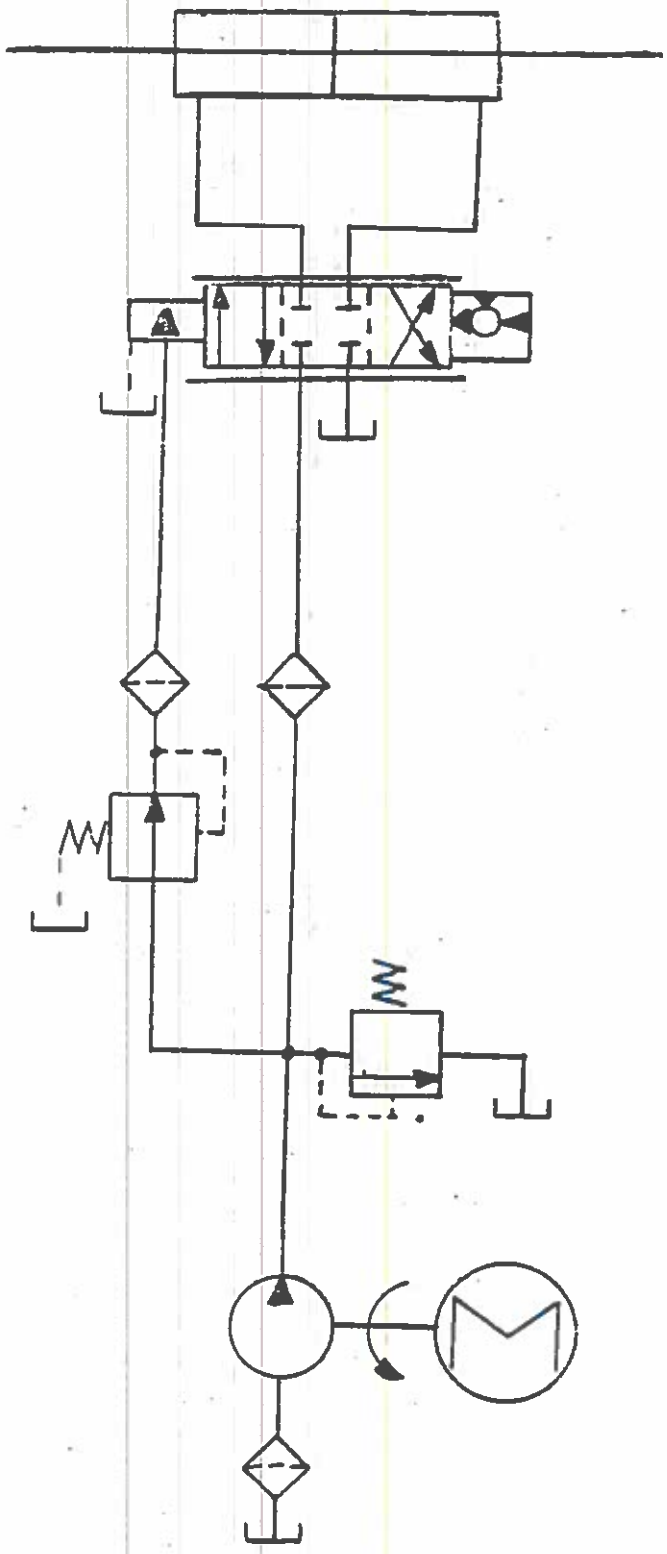
Double shaft extension
motor - 2 separate pumps

Figure 2



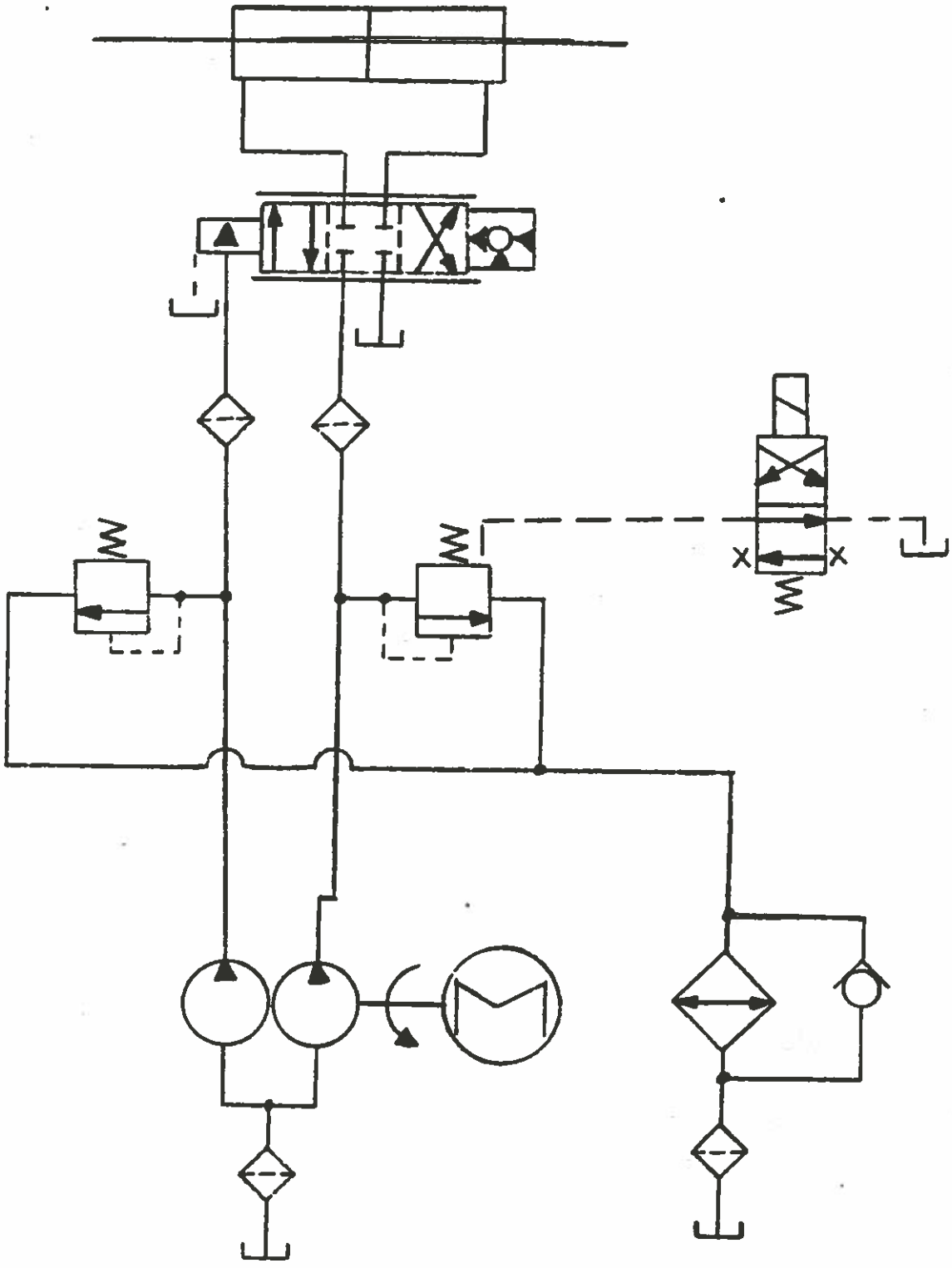
Double pump

Figure 3



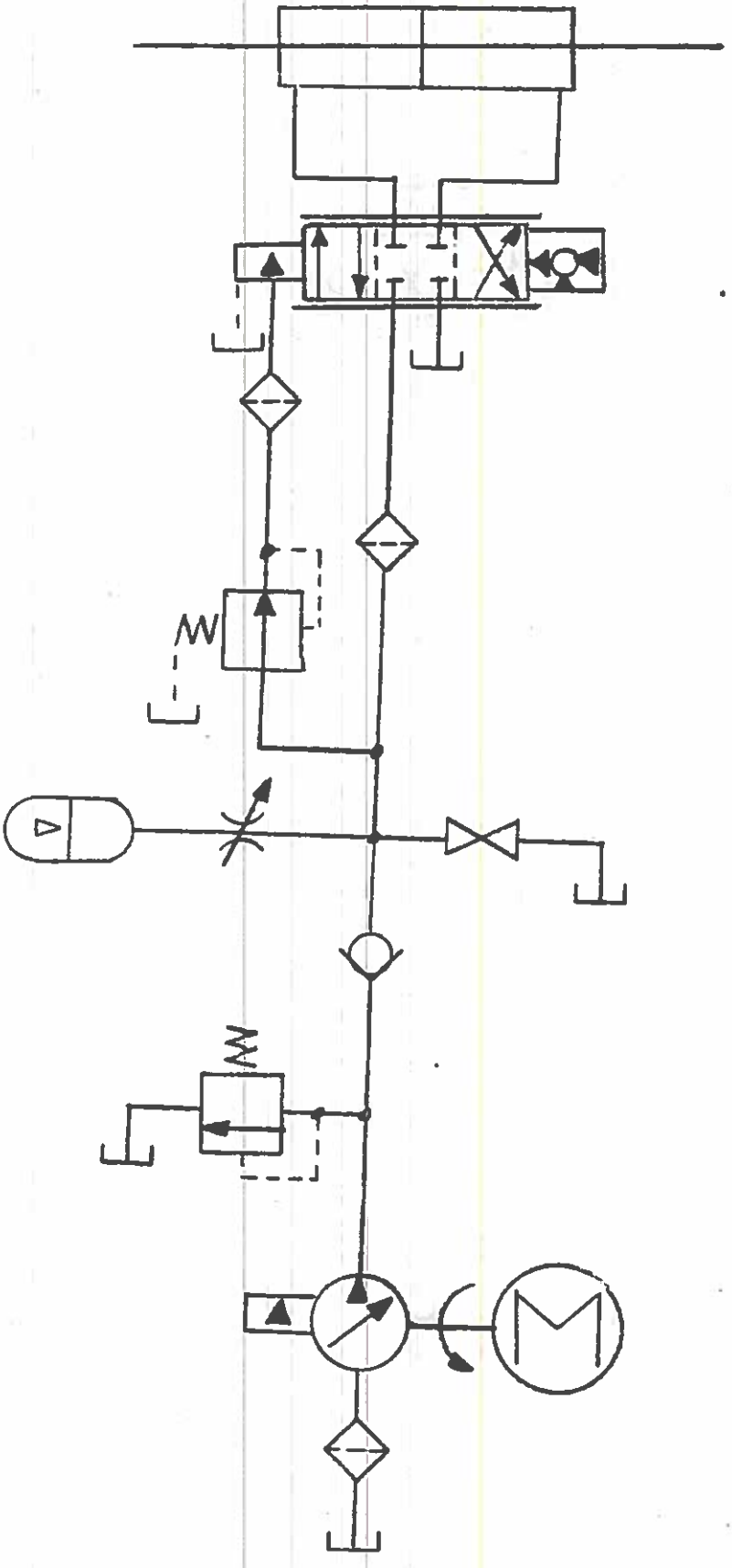
Single pump and reducing valve

Figure 4



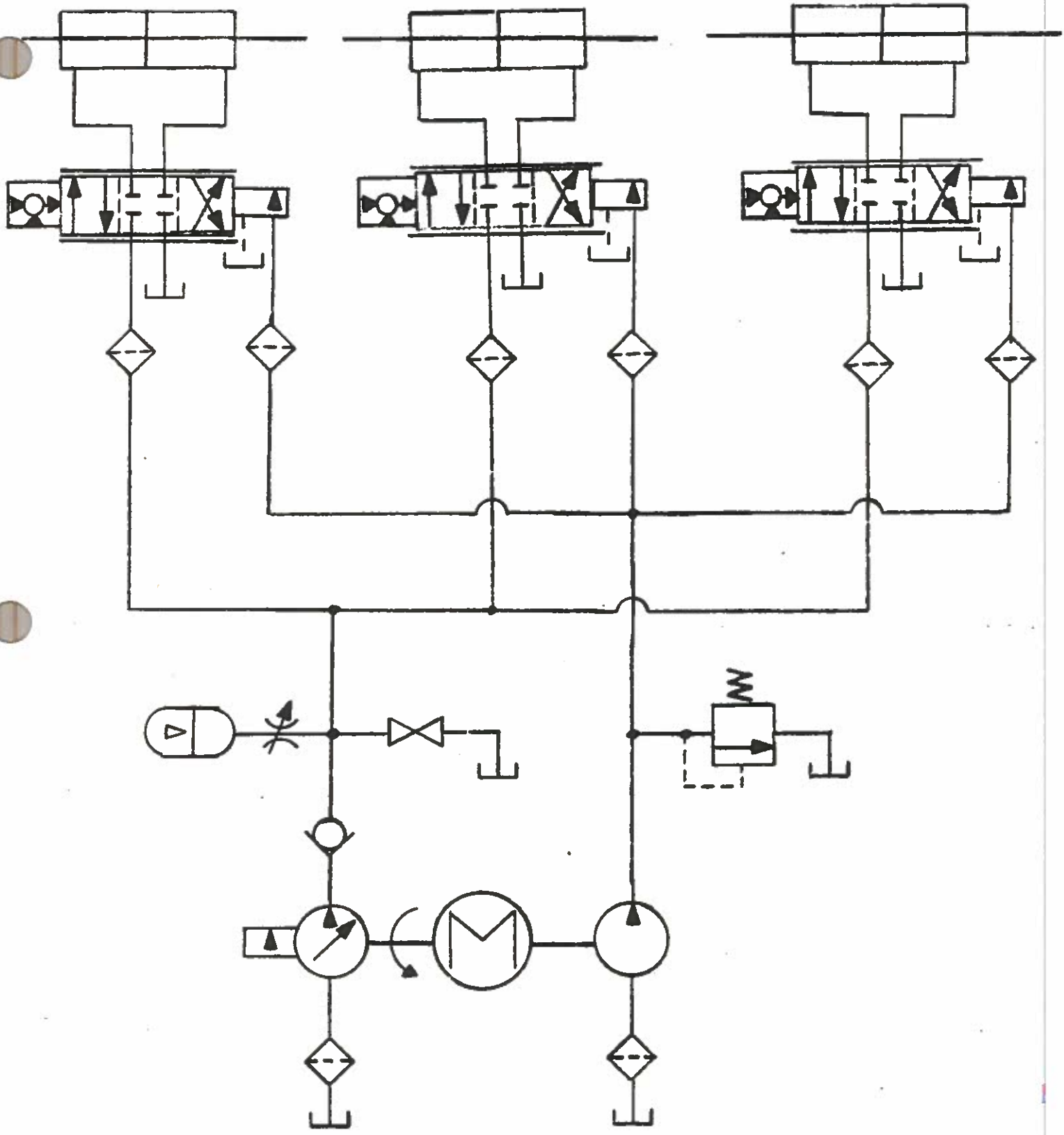
Venting the relief valve
Use of heat exchanger

Figure 5



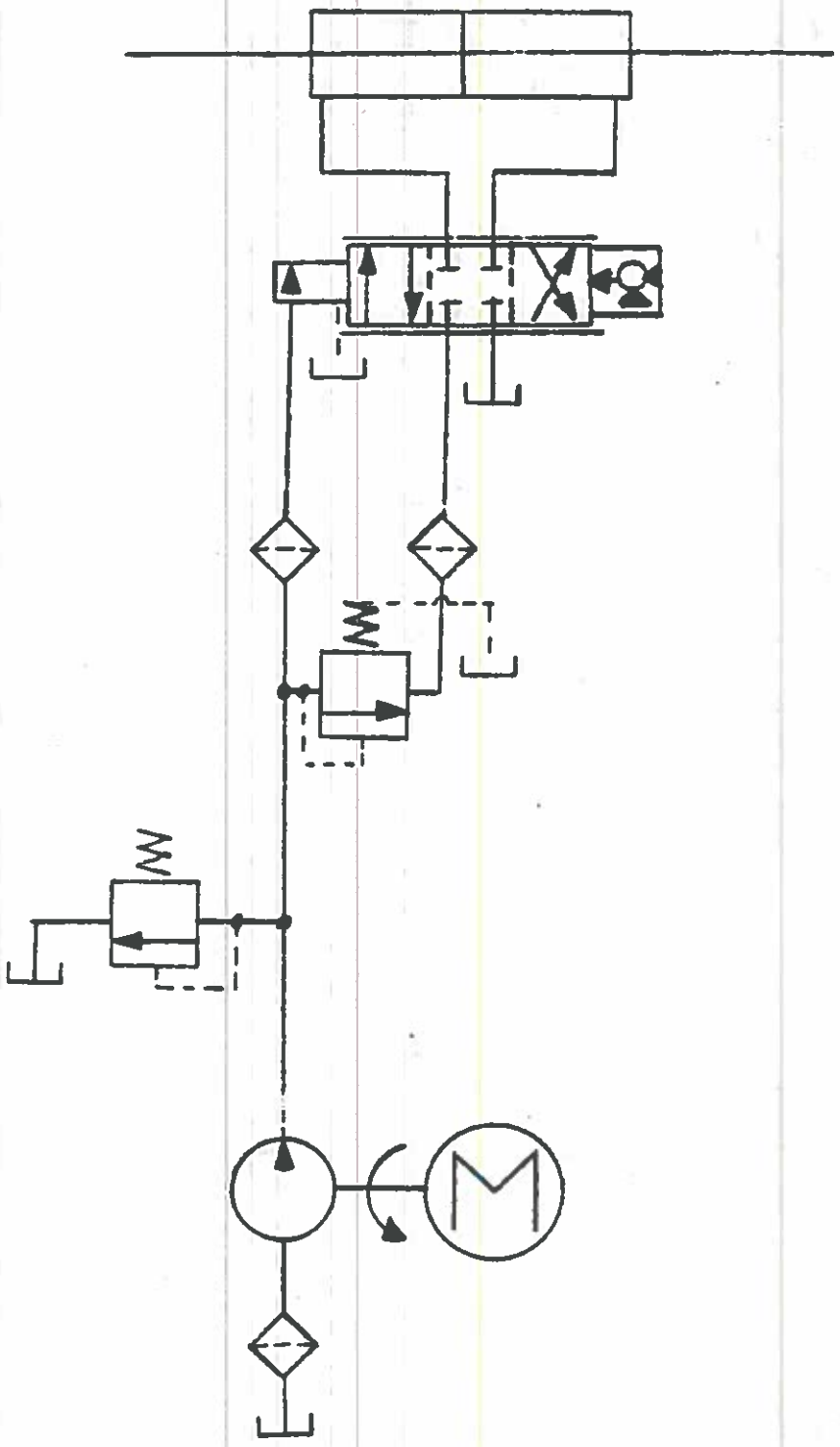
Pressure compensated pump

Figure 6



More than one servo valve on a machine

Figure 7



Use of a sequence valve

Figure 8

CARE OF A SERVO SYSTEM

A. PRELIMINARY PROCEDURES

RESERVOIR PREPARATION PRIOR TO INSTALLATION

General Requirements: When installing a reservoir in a hydraulic system, it is necessary that it be cleaned thoroughly, to insure it is reasonably free from scale and all kinds of foreign matter. The following measures may be taken to achieve this:

1. The inside of the reservoir should be brushed with a good bristle brush using a solvent as the cleansing agent. (Consult your fluid vendor for compatible solvent.) CAUTION: Do not remove the paint from the inside of the reservoir. Remove residue of solvent with filtered shop air. Install new end cover gaskets. Install a 200 mesh screen in the filler pipe and an adequate breather cap to seal out the dirt. Mount the reservoir on a sturdy and level base. Locate reservoir so that it can be cleaned. Check to insure that means are provided for sealing around the outside diameters of all lines entering and leaving the reservoir.

   Tubing, pipes, and fittings should be prepared according to Vickers Application Data Sheet M-1221-S, "Preparation of Pipes, Tubes, and Fittings Before Installation in a Hydraulic System".

   Install 10 micron full flow filters in the hydraulic supply lines to the valve (main supply and control pressure if used).

B. FLUSHING PROCEDURES

1. Fill the reservoir with fluid maintaining an air space above surface of oil. (All fluid added to reservoir must be filtered by a 10 micron filter.)

2. The system, to include the reservoir, tubing, valves, filter, actuator, and servo valve manifold (with a flushing plate in lieu of the servo valve) is now ready for flushing.

3. The use of the servo valve flushing plate allows the fluid to flow from the pressure line to the manifold and directly back to the reservoir. This allows the fluid to recirculate and flush the system, trapping the foreign particles in the filter media. The filter element should be inspected periodically (1 or 2 hours) during the flushing period to insure that it has not become clogged and the bypass has not opened. Changing of the filter element is necessary when it has indications of becoming clogged. The period of flushing depends upon the overall system configuration and system contaminant level. When sampling of the filter media indicates that little or no additional contaminants are present, install a new filter element, remove the flushing plate and install the servo valve. CAUTION: Do not over-torque servo valve mounting bolts. Replenish any lost oil to the reservoir.

C. PLANNED MAINTENANCE

After the system is operational it now becomes very important that measures are taken to prevent contaminants from entering the system.

1. Contaminants sources can be built in contaminants, sand, weld metal chips, and textile lint. Most of these can be removed by following the preliminary flushing procedures.

2. Generated contaminants - the wearing of parts and migration of particles of elastomers and gaskets used in sealing, caused by moving parts.

3. Contaminants may be introduced into the system through fluid filler pipes, breather caps, openings around pipes, and tubes entering the reservoir. A defective shaft seal on an internally drained pump may take in air and contaminants. (This condition is more severe with a poor inlet condition.) Piston rods of actuators may allow contaminants to enter the rod side of the cylinder and by adding replenishing fluid that is contaminated to the reservoir.

4. Products of fluid decomposition - sludges, varnishes, acids, and tars can form due to a chemical reaction taking place. These changes are due to water, heat, air, and pressure as well as the mixing of different types of fluids.

D. PERIODIC OBSERVATIONS

1. Wear particles can be trapped by installing and having periodic attention to filters. (Preferably 10 micron full flow.) The frequency of changing filters after operation is generally three months or 500 hours or more often if necessary.

2. Contaminants introduced into the system can be minimized by maintaining good housekeeping practices, such as filter all fluid added to the reservoir through a 10 micron filter. Keep the tops of the reservoir free from dirt and other fluids. Maintain adequate sealing around lines entering the reservoir.

3. Breakdown of the fluid can be curtailed by maintaining a recommended operating temperature and prevent inter-mixing of the hydraulic fluids with cutting oils, water, and other fluids.

4. Check shaft and coupling alignment. Mis-alignment, in some cases, can cause side loading of shaft bearings and shaft seals which can allow contaminants to enter the system.

5. In a dusty environment it may be necessary to install a boot on rods of cylinders as a preventive measure to seal out contaminants from entering the system through a worn rod wiper.

VICKERS®

TROUBLE SHOOTING

SERVO SYSTEMS

In recent years many industries have begun to use servo controlled machines. Applications exist in such fields as food packaging, paper making, steel making and machine tools, to mention a few.

One of the problems involved in switching from manually controlled or semi-automatic machines to fully automatic or programmed machines is manpower. These machines, which may be controlled by signals from punched cards, punched tape, magnetic tape or similar inputs, require the services of engineers, plumbers, machine repairmen, electricians, etc., in various phases of installation, start-up and maintenance. Men in these different fields found that they had to move from their own specialties into an area of understanding in the related trades in order to install and service the automatic machines adequately. Servo controlled or electro-hydraulically operated machines require the integration of electronics, hydraulics, and mechanics at least.

We will be concerned primarily with problems connected with initial set-up and trouble shooting in systems using Vickers building block components, but what applies here will also apply to any electro-hydraulic system.

The most difficult task involved in solving a system problem is to determine the actual cause. The diagnosis must determine whether thr trouble is caused by an electronic, mechanical, hydraulic malfunction or a combination of these.

I. TERMINOLOGY:

A. As an aid to our understanding of the procedures to follow, a list of the more commonly used terms follows:

1. Command Signal - input signal which tells the machine what to do.

2. Feedback Signal - signal from the output motion which is brought back for comparison to the input to determine compliance.

3. Feedback Transducers - devices at the controlled output which send back a signal to the input. May be potentiometer, tachometer, generators, synchros, etc.

4. Amplifier - an electronic, magnetic or semi-conductor device to increase signal strength to a usable level.

5. Servo Actuator - controlled hydraulic motor or cylinder which powers the load.

6. Servo Valve - an electro-hydraulic device which controls oil flow to an actuator determining speed and direction of output motion.

7. Torque-Motor - an electro-mechanical device which converts electrical energy to mechanical movement which is proportional to the electrical energy received.

B. Various control components have characteristics and functions that affect the operation of any system. How well they perform determines the accuracy of the entire system, so a look at what these things are and where they might be troublesome will be of help.

1. Gain - may be defined as the amount of increase that a signal, either from a command or feedback source receives as it passes through a control system or control element.

2. Balance - electrical and mechanical

   (a) Electrical - adjustment of amplifier controls so that with no command signal the amplifier output will be null.

   (b) Mechanical - adjustment of the physical position of the servo valve parts so that with no electrical signal received there will be no oil flow or output to the load.

3. Dither - a high frequency, small amplitude A.C. signal superimposed on the D.C. control signal to reduce deadband caused by static friction.

4. Viscous Dampening - a control element (variable cross line orifice) built into the servo valve manifold to diminish the system's natural tendency to over-correct.

II. ADJUSTMENTS:

A. Amplifier Gain Adjustment

1. Too low -

(a) Response time slow or sluggish
(b) Positional accuracy poor

2. Too high -

(a) System unstable
(b) Tendency to oscillation

Observation of response can often be made without instrumentation. If instrumentation is available, output response may be compared with a step signal input by means of a brush type recorder or oscilloscope. Response should not lag too much nor should there be overshoot or a hunting condition as the output follows the input. Gain should be as high as possible without causing instability.

B. Feedback Gain Adjustment - if used

1. Allows use of one amplifier with output transducers which provide various amounts of feedback signal strength.

2. Too low - results similar to low amplifier gain.

3. Too high - results similar to high amplifier gain.

C. Amplifier-Electrical Balance if not correct -

1. May limit system response to only one direction or to different maximum outputs in opposite directions.

2. Has a tendency to drift causing poor speed control or positioning inaccuracies.

3. May be caused by changing or replacing any components affecting the electrical system.

D. Servo Valve or Mechanical Balance -

1. Should Be Done

(a) After system is up to operating temperature. (Parts expansion can cause null shift.)

(b) After electrical balance has been established.

(c) Open-loop, i.e., with feedback signals disconnected.

2. Results in no output motion of actuator.

E. Dither -

1. Not required in all systems but is advantageous for all systems.

2. Decreases "dead-band" and by making system respond to small input signals increases output accuracy and repeatability.

3. Too little dither causes erratic action.

4. Too much dither causes system to lack response and have low power at a given positioning point. Also causes undue wear of the moving parts.

5. Should never be great enough to be sensed at the output, either motor or cylinder.

III. CONSIDERATIONS:

A. Whenever a servo system malfunctions, there are several points to check:

1. Dirt in hydraulic system
2. Backlash in feedback device
3. Loose wiring
4. Mechanical bind
5. Machine compliance
6. Defective actuators
7. Mis-alignment of shafts to transducers
8. Inquisitive employees turning knobs, etc.
9. Defective tachometers, synchros, resolvers, etc.
10. Low voltage
11. Heat in electrical and hydraulic components
12. Non-linearity in transducers
13. Electrical noise from relays, etc.

The greatest difficulty in trouble shooting a servo system is to diagnose the fault properly. Time spent in considering the symptoms can avoid a large amount of unnecessary labor in tearing things apart. The difficulty may be electrical, hydraulic or mechanical.

Minimum equipment would be a volt-ohm-meter (VOM) or vacuum tube volt meter (VTVM) for checking the various signals, and pressure gauges for checking the hydraulic system. In high performance systems, recorders of the brush type or oscilloscopes may be needed to get visual indication of performance.

IV. GENERAL OBSERVATIONS:

A. The following points may be checked in determining difficulty in a "won't operate" situation.

1. Is command signal correct for desired output action?

2. Is amplifier output to torque motor correct for the command input in magnitude and polarity?

3. If wiring to various components correct and complete? (Loose connections, broken wires, etc.)

4. Check supply pressure and control pressure. See that all manually operated valves are properly set.

5. Check that pressures in the lines between servo valve and actuator are equal. (Balanced actuator and valve at null.)

6. Check for mechanical bind in machine.

7. Check for excessive leakage:
   (a) From motor drain.
   (b) Blow-by past cups or rings of piston in cylinder.

B. The following points may be checked in systems with intermittent difficulties:

1. Dirt in hydraulic system

2. Check for proper amount of dither

3. Check all mechanical drives for bind or backlash in transducers

4. Check programming signal for intermittent output during machine operation

5. Check amplifier output as in previous step

6. Check feedback devices for brush lift or other interruptions in output

7. Check wiring for opens or shorts which might be intermittent, due to vibrations or temperature changes

8. Check for dirt in servo valve. This is last because it requires dismantling the valve and is time consuming. It also increases possibility of introducing contaminants to the system.

While there is no one difficulty that will cause a particular faulty action, and consequently no one particular cure, the following suggestions should be of assistance in trouble shooting a servo system.

V. TROUBLE SHOOTING SPECIFIC COMPONENTS:

A. Pump

1. No oil flow from pump

   (a) Improper drive shaft rotation
   (b) Broken drive shaft
   (c) Oil level in reservoir too low
   (d) Improper assembly
   (e) Loose coupling

B. Excessive Noise

1. Cavitation Occuring (Continuous metallic growl)

   (a) Dirty or clogged intake strainers
   (b) Restricted inlet line
   (c) Excessive drive speed

2. Aeration Occuring (Sporadic gurgling)

   (a) Oil level too low
   (b) Loose intake connection
   (c) Defective shaft seal
   (d) Return lines above oil level

3. Misalignment

   (a) Drive shaft misaligned
   (b) Defective coupling
   (c) Mounting surface deflected
   (d) Loose mountings

4. No Pressure

   (a) Badly worn pump
   (b) Loss of full pump delivery through faulty pressure control

C. Pressure Control - Relief Valve

1. Erratic Pressure

   (a) Worn piston or seat in cover
   (b) Piston in main body sticking
   (c) Contaminated fluid

2. Little or No Pressure

   (a) Vent connection open
   (b) Small balance hole in main piston blocked
   (c) Piston in top cover not seating
   (d) Main piston binding in body or cover

3. Noise or Chatter

(a) Faulty or worn piston or seat in cover
(b) Long vent line used without a restriction
(c) Interaction with another pressure control (pressure settings too close).

D. Pressure Control - Pressure Reducing Valve

1. Erratic Pressure

(a) Contaminated fluid
(b) Worn piston or seat in top cover
(c) Valve spool binding in body
(d) Drain line restricted

E. Servo Valve and System

1. No movement at the load with an apparent change in the command device

(a) Insufficient control pressure (two-stage valve).
(b) Improper manifolding-ports blocked or connected incorrectly.
(c) Servo valve mounting bolts over-torqued causing spool bind.
(d) Electrical - no output from amplifier
(e) Torque motor inoperative
(f) Contaminated fluid

2. Load movement in only one direction

(a) Spool not centered
(b) Amplifier not balanced
(c) Flow port blocked, improper manifolding or connected improperly
(d) Pilot spool not centered (two-stage valve)

3. Movement of load in both directions, maximum velocity in only one direction

(a) Torque motor misaligned
(b) Amplifier out of balance
(c) Pilot spool not centered (two-stage valve)
(d) Main sleeve too far out of adjustment (two-stage valve)
(e) Contamination

4. Erratic load movement

(a) Contamination
(b) Torque motor misaligned
(c) Servo valve mounting bolts over-torqued
(d) Erratic input signal or intermittent electrical connection

5. Uncontrolled load movement

   (a) Amplifier or signal source defective or inoperative
   (b) Torque motor defective or inoperative
   (c) Servo valve mounting bolts over-torqued
   (d) Torque motor misaligned
   (e) Insufficient control pressure (two-stage valve)

6. Load moves in wrong or opposite direction

   (a) Torque motor wiring incorrect
   (b) Amplifier, signal source current polarity, or feedback wiring incorrect

7. No response with change in command signals

   (a) (Two-stage valve) Insufficient control pressure
   (b) (Initial start-up) Improper manifolding or not piped correctly
   (c) Servo valve mounting bolts over-torqued causing distortion
   (d) No output from amplifier
   (e) Torque motor inoperative

8. Servo valve goes hard over

   (a) Feedback phasing improper

19

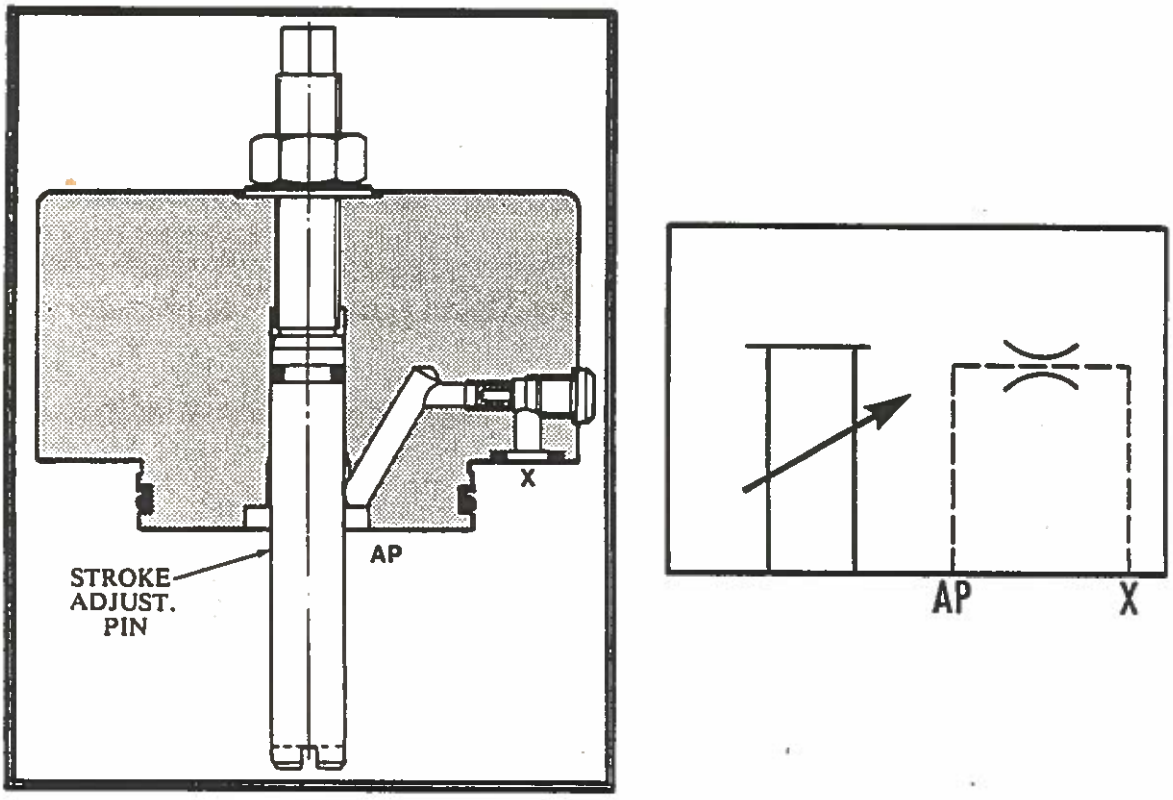


FIGURE NO 17

STORKE ADJUST COVERS

A cartridge valve with stroke adjust cover is used to provide flow regulation and directional control in a single unit. Flow regulation is obtained by limiting the travel or stroke of the main poppet. In this way an adjustable throttle or variable orifice is created.

The throttle opening is set by the position of a pin which extends into the insert spring chamber. The pin forms a stop for poppet opening. the arrangement of parts with standard screw and locknut adjustment is shown below.

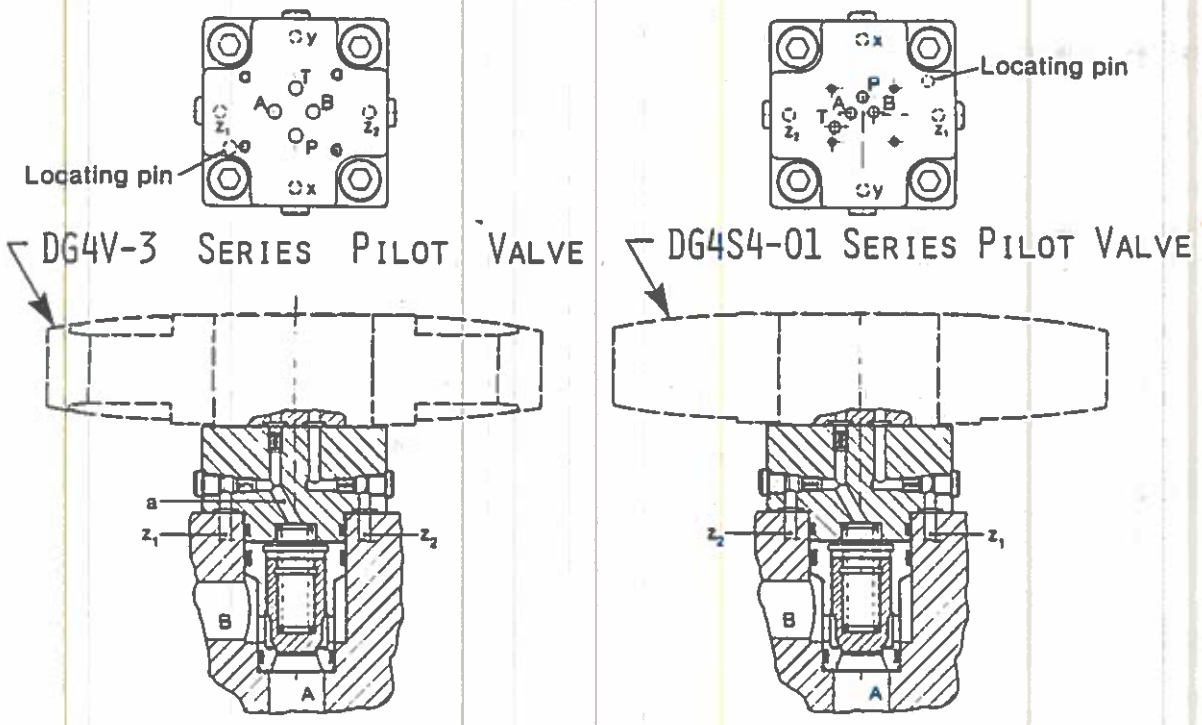
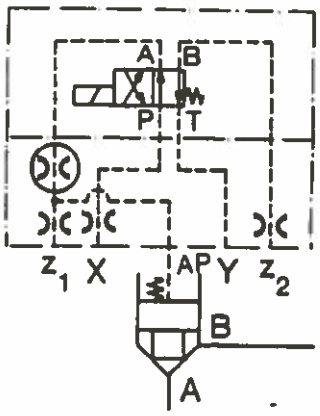


Figure No. 18

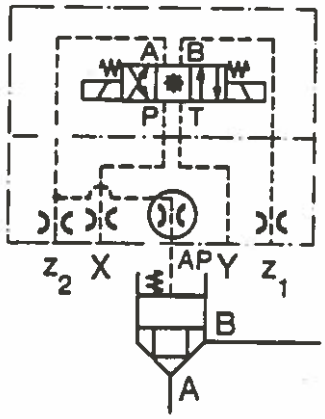
COVERS WITH PILOT VALVE INTERFACE

Covers with a pilot directional valve interface are available in all sizes except. The 16, 25 and 40mm covers have an NFPA D-01 face for mounting a DG4V-3 pilot valve. The 50 and 63mm covers have a D-02 face which takes a DG4S4-01 valve.

Note that the 16, 25 and 40mm covers connect auxiliary port Z with the insert spring chamber while the 50 and 63mm covers connect the Z2 port with the spring chamber. This is due to the difference in the pilot valve port patterns. They are shown in the top views.



16 THRU 40MM COVERS



50 AND 63MM COVERS

Figure No. 19

In this figure the cartridge valve covers are shown schematically with pilot directional valves mounted on top. Either single or double solenoid valves can be used. The damping orifices shown circled comes installed in the covers. The other indicated orifices may be installed if needed.

Pilot pressure at the X port is connected in the cover to the P port of the directional valve. The T port is connected to Y which is a drain passage. Auxillary ports Z1 and/or Z2 may be connected in the manifold to other valve pilots to provide simultaneous operation of more than one cartridge valve with one pilot valve.

The schematic of the 16, 25 and 40mm valves shows the pilot valve in the spring-offset position. Pilot pressure from the X port is transmitted through the pilot valve (P to A) to the insert spring chamber thereby holding the cartridge valve closed. When the solenoid is energized, the spring chamber is drained through the pilot valve (A to T) to the Y (drain) port and thus the cartridge valve opens to allow flow in either direction.

VALVE RESPONSE

Valve response, the timing and rate of opening or closing of the main valve poppet, is a function of the damping orfice size and the system pressures applied to the "a", "B", and pilot pressure ports of the valve. In most cases the standard orifice supplied in the cover will give satisfactory valve response. If needed, critical machine functions can be optimized or tuned by changing the appropiate damping orifice sizes to modify valve response. Larger orifices give faster response (and less damping); smaller orifices give slower valve action. Orifice plug kits include several size orifices plus a blank plug. The use of orifices smaller than 0.8mm (.032 in.) diameter is not recommended for most hydraulic systems due to possible clogging by system contamination.

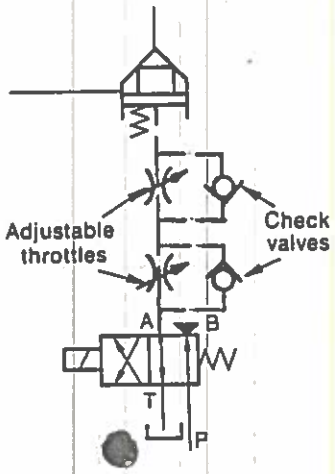


FIGURE 20

A moduler block maybe used with a directional valve cover to provide an adjustable response of the main poppet.

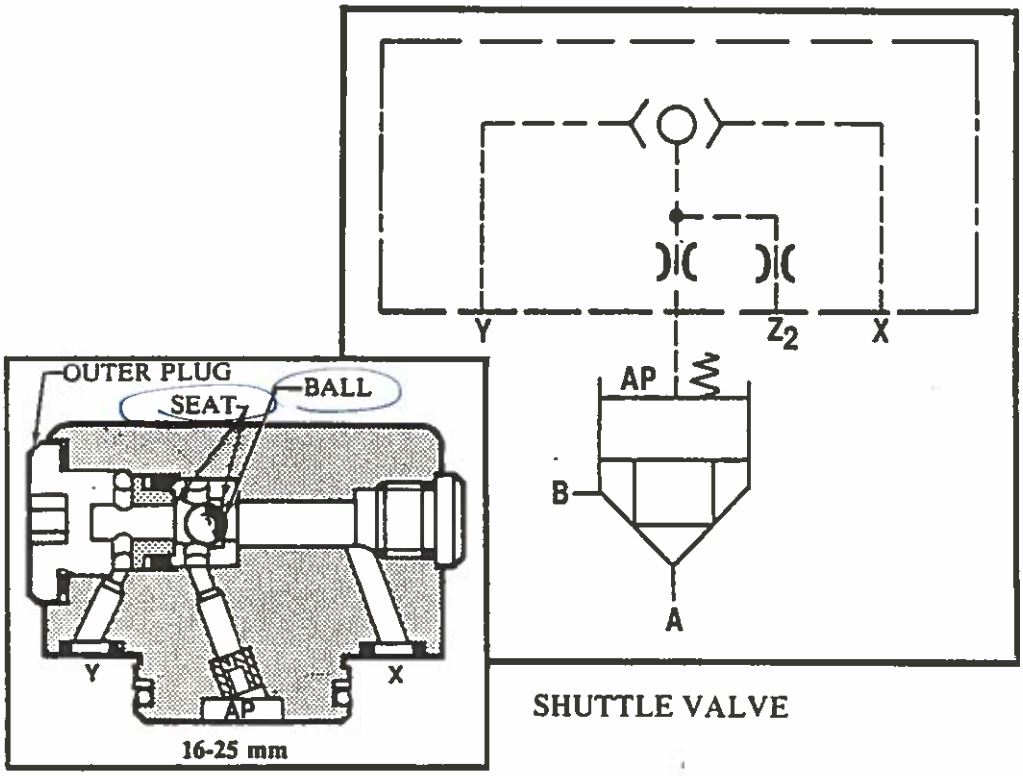


FIGURE NO 21 SHUTTLE VALVE COVERS (Standard)

A shuttle valve cover takes the higher of two pilot pressures and directs it to pilot spring area AP. A schematic diagram of the shuttle valve is shown here. The X port and the Y port feed fluid to each end of the shuttle., The spring chamber (area AP) is connected to the center section of the shuttle. The Z2 port is also connected to the center section of the shuttle.

A seat is pressed into the cover bore and a ball is inserted. The outer plug is then threaded into the cover. The shuttle valve ball seat which prevents flow between AP and Y is machined on the end of the outer plug. An "O" ring and back-up ring located on the plug, prevent leakage between the AP and Y port areas; another "O" ring prevents external leakage.

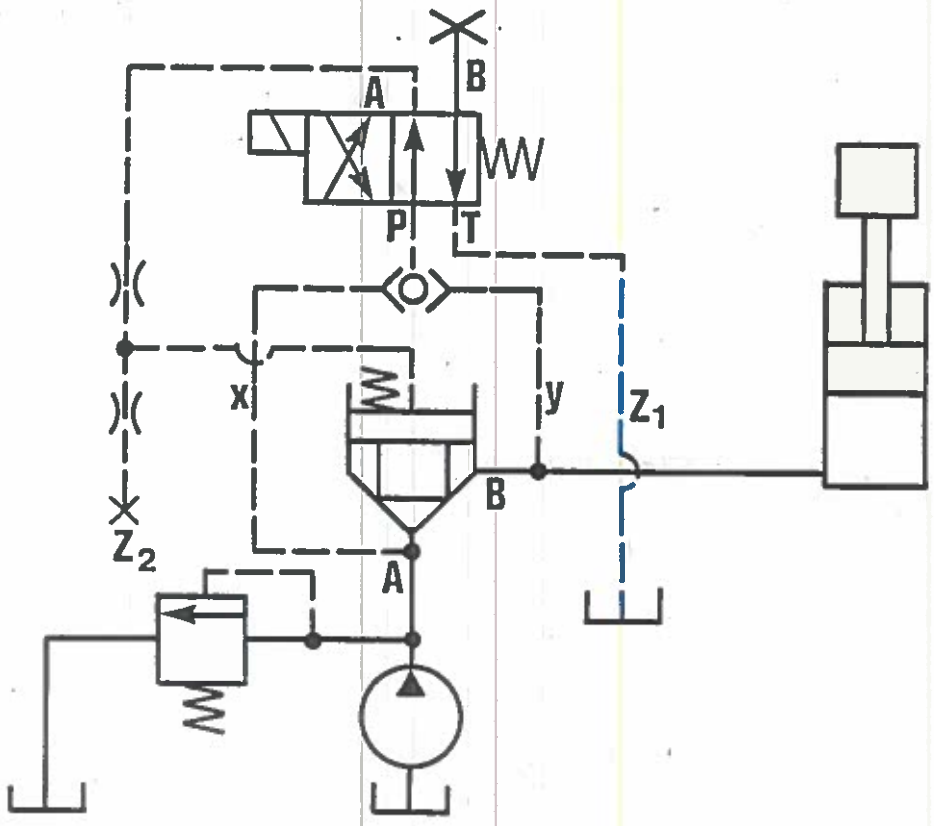


Figure No.22

When the system requires an on/off valve with flow capabilities in either direction a shuttle cover with directional valve interface may be used as shown in this figure.

When the solenoid is de-energized, the highest pressure in port X or Y is transmitted through the shuttle valve to the poppet spring area. Thus the valve will close whether A and B are at equal or unequal pressures because the spring force added to the higher of the A or B pressures will overcome the A and B pressures trying to open the valve.

22

FIGURE NO. 22 (cont'd)

Energize the solenoid and the poppet spring chamber is drained. Now fluid can travel in either direction as long as it has enough energy to overcome the spring holding the poppet closed.

To convert this circuit from "normally closed" to "normally open" replace the right hand spring offset valve with a left hand model. This will change the spring offset path from P - A to P - B.

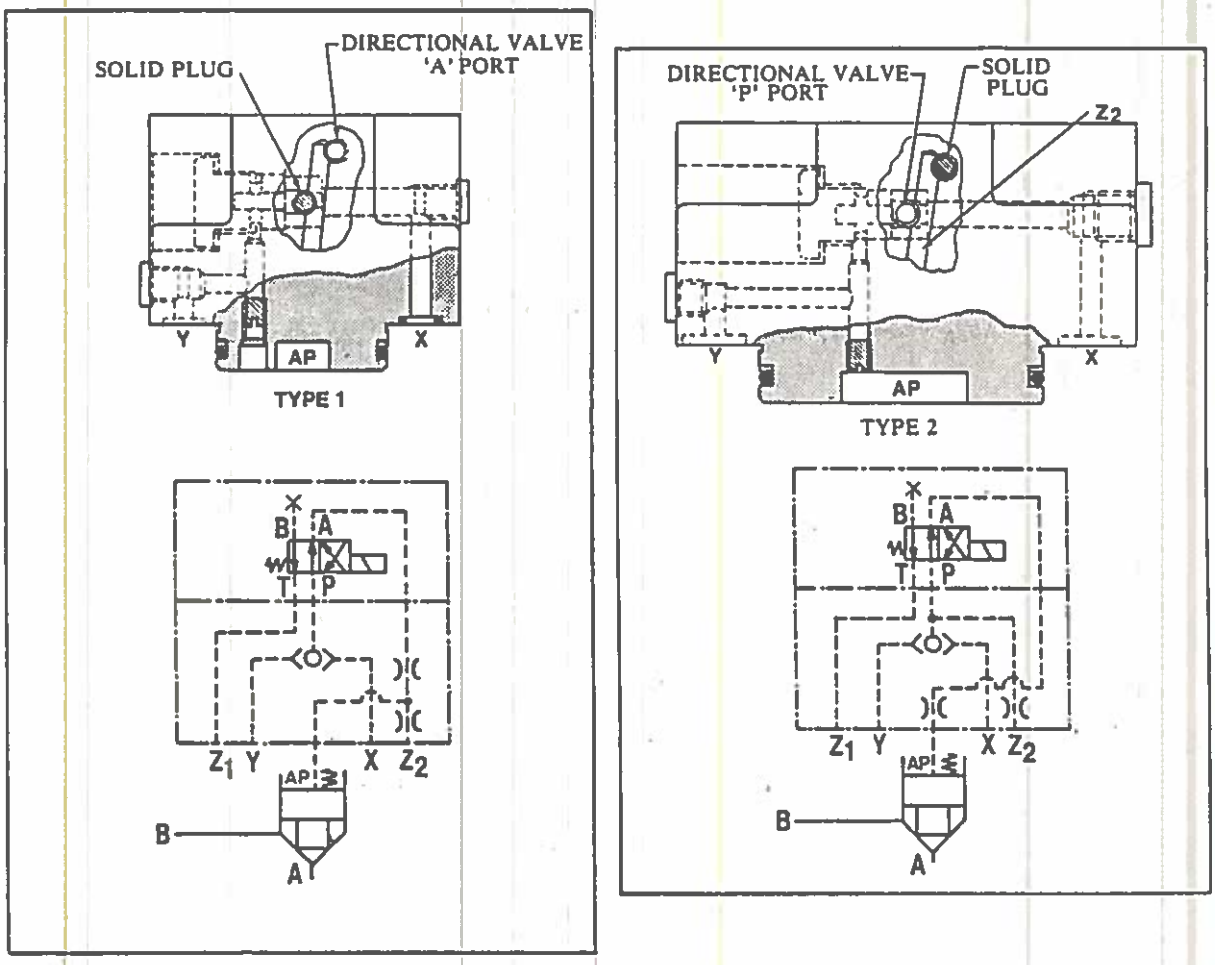


FIGURE NO. 23 SHUTTLE VALVE COVERS WITH NFPA-DØ1 INTERFACE

A shuttle valve with a directional valve mounted on its NFPA-DØ1 interface expands a basic check valve to a check/on/off device. Shuttle covers are available in the 25, and 40mm sizes. They are not available in the 5Ø and 63mm sizes. Two configurations of the shuttle valve are available, type 1 and type 2. The difference between the two is an assembly change which picks up the Z2 port from a different location in the cover. The change from one assembly configuration to the other is made by exchanging the location of a solid plug. This plug is not visible without removing external plugs from the cover.

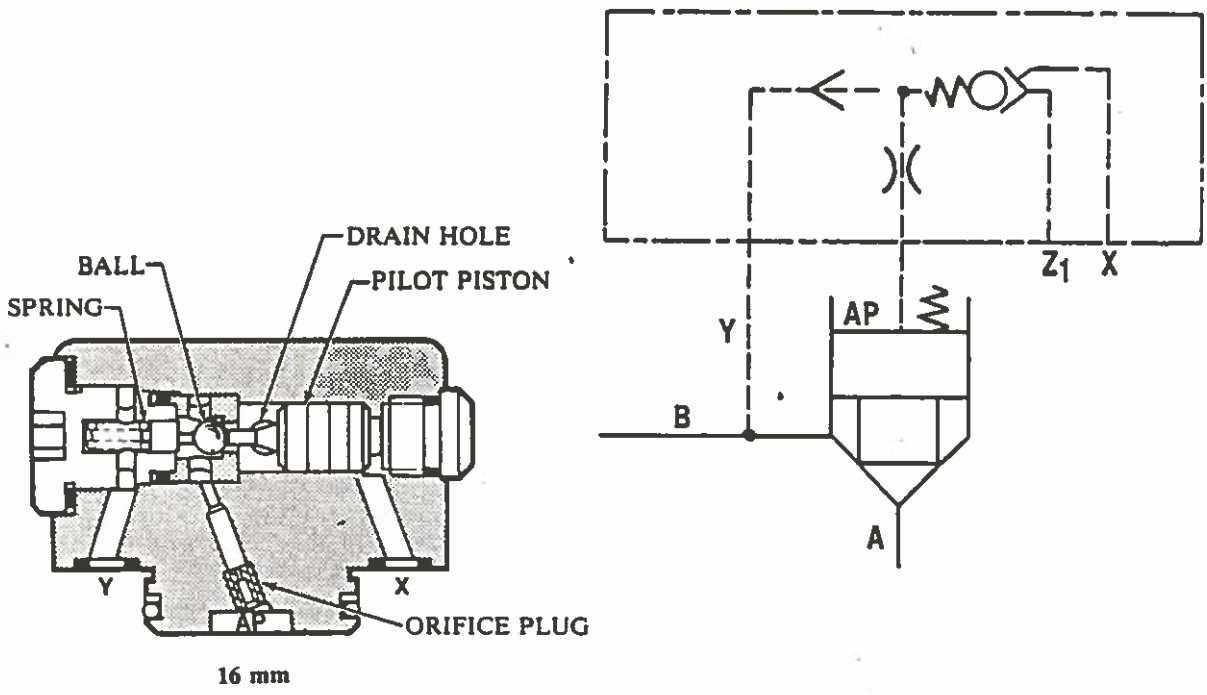


FIGURE NO 24 PILOT OPERATED CHECK COVER

The pilot operated cartridge check valve can be applied in much the same manner as other pilot operated checks. Three pilot ports are used:

1. The X port is drilled in the manifold to the pilot signal.
2. The Y port is drilled in the manifold to connect with the B port of the insert kit.
3. The Z1 port is connected to a drain line. When there is no X pilot signal to the valve, we have a simple check valve. Flow can pass from A to B if the pressure in the A port is greater than the sum of the pressure in the B port plus the spring force. Flow is blocked from B to A.

FIGURE NO. 24 (cont'd)

When sufficient pilot pressure is applied to the X port, the piston moves, lifting the check valve ball from its seat. This drains pilot spring area AP and closed the passage between area AP and Y. If the A port is pressurized, flow will pass from A to B regardless of the area ratio of the insert kit.If B port is pressurized, flow will pass from B to A providing the area insert kit ratio is 1:1.1 to 1:2.

The cartridge valve B port is connected to Y. When flow reverses, pressure is applied to Y from the B port and removed from X. The spring then shifts the check valve ball which blocks the passage to the Z1 port and the AP area is pressurized preventing the cartridge valve from opening.The pilot piston has an area 3.4 times the seat area of the check valve. This means that when system pressure is 3.4 times the pilot pressure, the pilot piston and ball are in pressure balance.

Make sure a pressure greater than one third (1/3) of system pressure is available for use as pilot pressure. The maximum allowable pilot pressure is 5000 PSI.

The pilot operated check valve is available in the 16mm, 25mm and 40mm sizes.

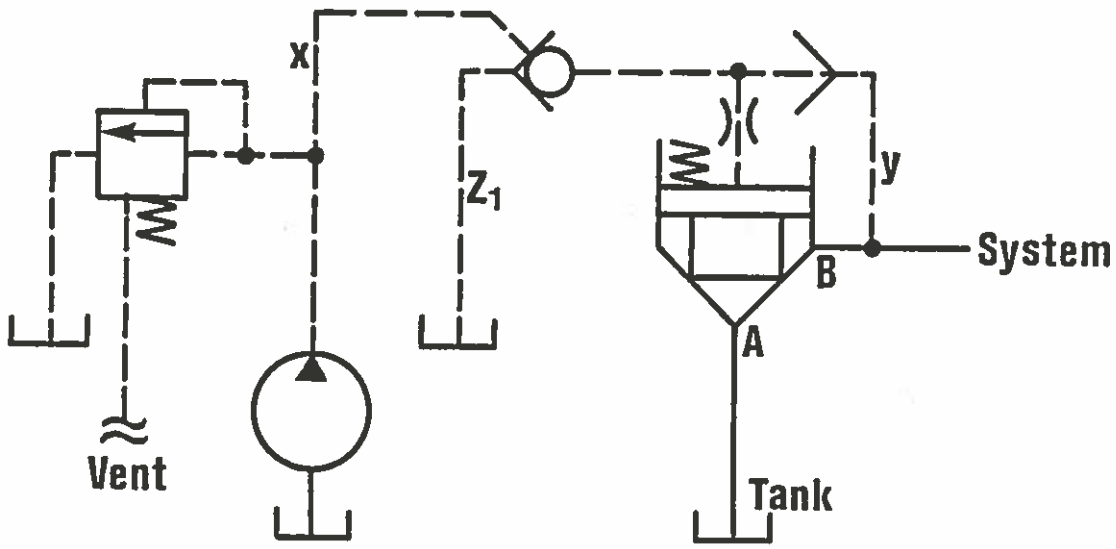


FIGURE NO. 25 PILOT OPERATED CHECK VALVE

It is important to remember that the 3.4:1 pressure ratio of pilot pressure to system pressure is in effect not only when the pilot valve ball is to be unseated but also when the pilot signal is removed to allow the ball to re-seat. This pressure relationship can cause a problem as is shown in this circuit. The designer of the circuit intended that the cartridge poppet would open B to A when pilot pressure from a separate source is applied to the pilot operated check via the X port. Closing the poppet was to be done by venting the pilot pressure relief valve.

The first operation, opening B to A, worked OK. However, when the relief valve was vented, the cartridge valve poppet did not close because the system pressure acting on the small ball area was not high enough to overcome the relief valve vent pressure acting on the larger (3.4:1) pilot piston area.The following figure shows one solution to this problem.

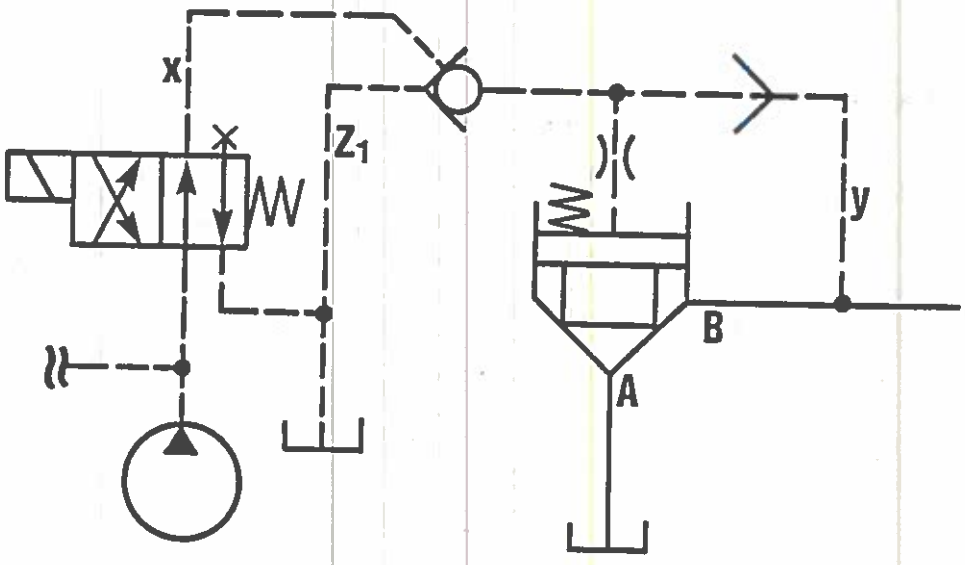


FIGURE NO. 26

The fix was to use a directional valve to apply or drain the pilot pressure. The tank port of the directional valve was connected to drain so the pilot pressure at the pilot piston did go to zero, allowing system pressure to close the cartridge valve,returning the main system to full operation.

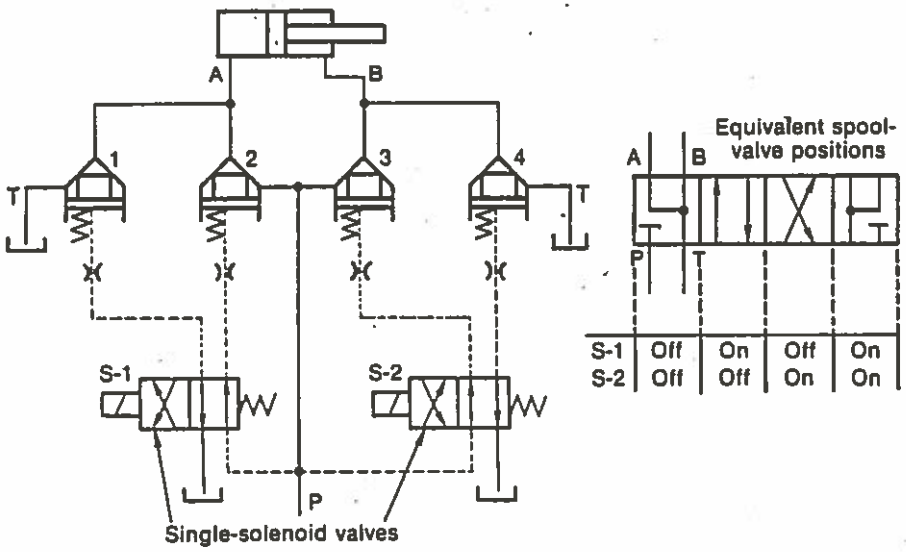


Figure No.27

This figure shows how the cylinder in the four cartridge circuit can be operated regeneratively without adding more solenoids. Simply replace the three-position, double solenoid pilot valve with two, two-position, single solenoid valves. When the two solenoids are energized simultaneously the cylinder will operate in a regenerative manner.

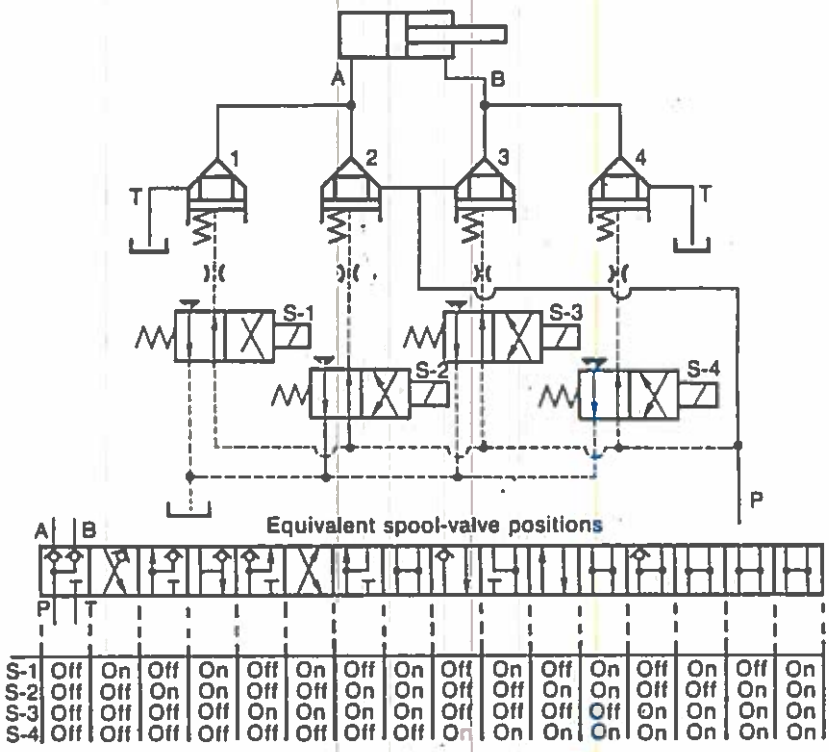

A
B
1
2
3
4
T
T
S-1
S-2
S-3
S-4
P
A
B
Equivalent spool-valve positions
P
T
S-1 Off On Off On Off On Off On Off On Off On Off On Off On
S-2 Off Off On On Off Off On On Off Off On On Off Off On On
S-3 Off Off Off Off On On On On Off Off Off Off On On On On
S-4 Off Off Off Off Off Off Off Off On On On On On On On On

Figure No. 28

Add just two more two-position, single solenoid valves to create an independent-control circuit. Operating each cartridge valve with a solenoid valve creates the equivalent of a sixteen-position spool valve. This arrangement enables each cartridge to be controlled independently, allowing a smooth transition from one operating phase to the next.

27

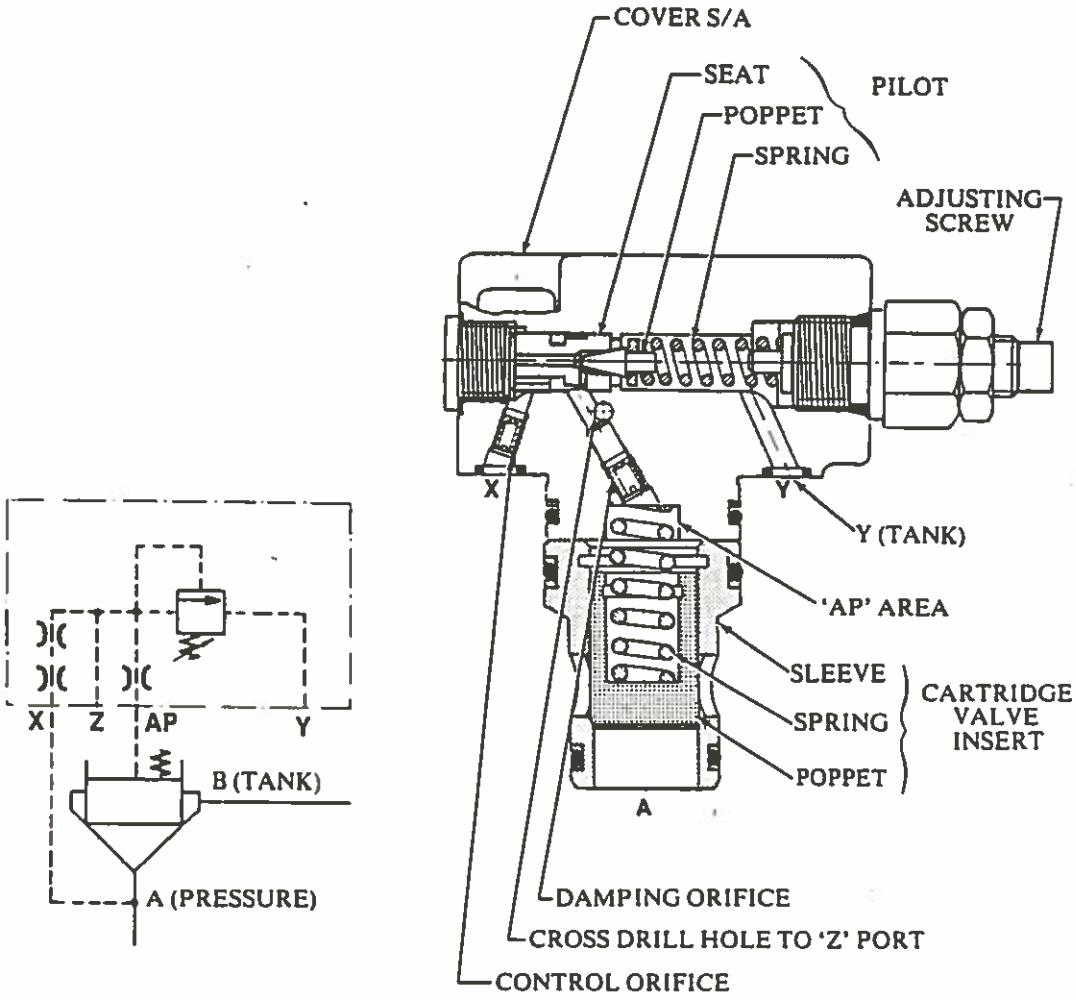


FIGURE NO.29 CARTRIDGE RELIEF VALVE

A cartridge relief valve performs in the same manner as the traditional type relief valve. It is a two-stage or compound relief valve. In the traditional relief valve, the pilot sensing port is a .040 inch hoile through the spool. In the cartridge relief the pilot sensing line is taken through the manifold, around the main stage, then through a .040 orifice in the cover.

Note the three pilot connections from the manifold to the cover. X is the pilot pressure connection. Y is the drain connection. Z is the vent connection.

FIGURE NO. 29 (cont'd)

Flow through the main stage is from A to B. Therefore, the X pilot port is connected to the A port. The Y is the drain connection. Z is the vent connection. Flow through the main stage is from A to B. Therefore, the X pilot port is connected to the A port. The Y port may be connected to B or to an external drain. Just as in traditional relief valves, any back pressure in the drain port will add directly to the setting of the valve.

The Z port may be drilled in the manifold to connect to a vent control or a remote pressure pilot. If it is not needed, it is simply not drilled in the manifold.

The recommemded maximum flow for each valve size is:

SIZE	FLOW	
	L/MIN	GPM
16mm	160	42
25mm	400	105
40mm	700	185

These flow rates are based on 4 bar pressuredrop with valve unloaded.

Three pressure ranges are available. The maximum pressure is changed by changing the spring in the pilot section. The main stage spring remains the same in all cases. By changing the pilot spring, we canachieve a maximum setting of 125 bar, 245 bar, or 350 bar(1800, 3500, or 5000PSI respectively).

28

FIGURE NO. 29 (cont'd)

PRINCIPLES OF OPERATION

The pressure setting of the valve is determined by the position of the adjusting screw which varies the spring compression.

In normal operation, the B port is connected to tank. The A and X ports are interconnected within the manifold. System pressure is present at A.

The system pressure at the A port is fed to the X port and communicated through the control orifice into area AP. Area AP is located directly above the cartridge insert poppet. This allows the cartridge insert poppet to be in hyeraulic balance and held against its seat by a light spring. Note: The orifice located in the AP area feed passage is used to slow reaction time of the spool and this prevents instability.

When system pressure at A exceeds the cover spring setting it forces the pilot poppet away from its seat. Fluid will flow through the control orifice, across the poppet and through the Y port to tank. Flow through the control orifice develops a pressure drop that subtracts from system pressure. The orifice pressure drop prevents pressure in the AP area from rising above the pilot poppet cracking pressure. When system pressure at the A port exceeds the pressure of the AP area sufficiently, the cartridge poppet will lift and throttle fluid from A to B, This limits system pressure at A.

FIGURE NO. 29 (cont'd)

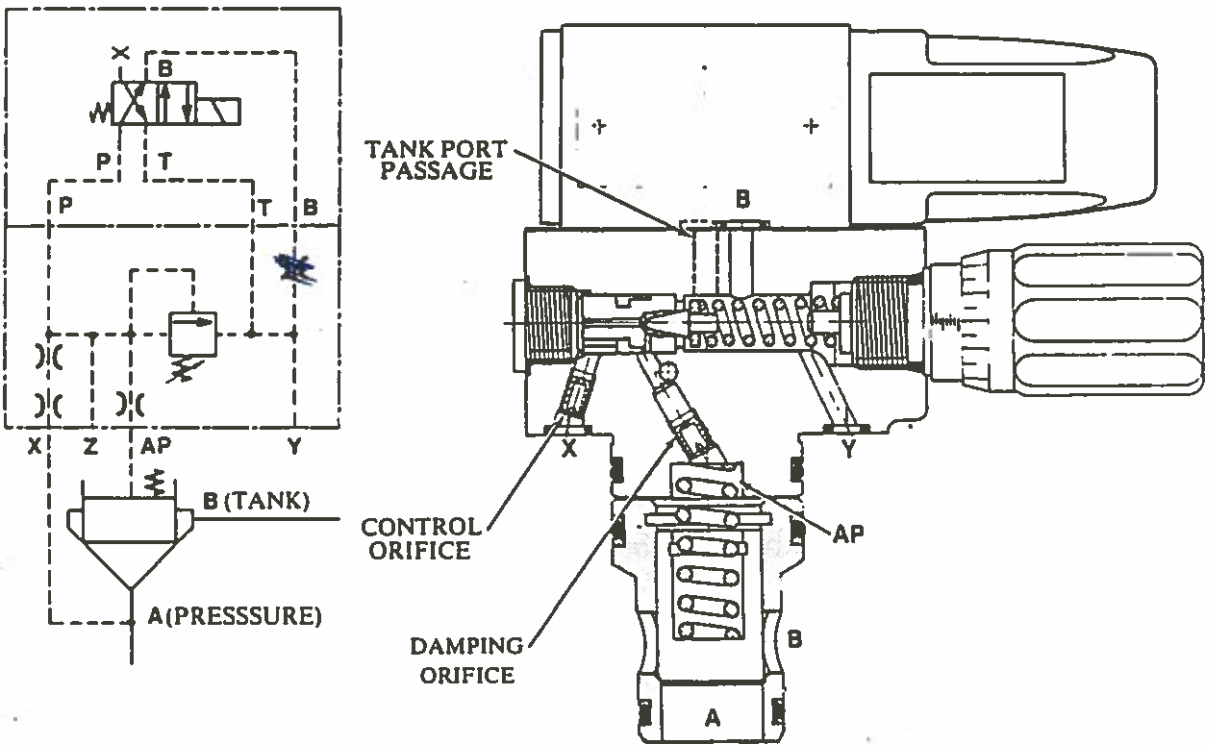
VENT FUNCTION

Venting the valve by opening the AP area to tank will permit flow to occuir from A to B at a pressure of approximately 5 bar.

Note: Vent pressure is limited only by the light spring of the cartridge poppet plus any back pressure present in the vent line. The AP area is connected internally within the cover to the Z port. Opening the Z port to tank vents the valve.

29

FIGURE NO. 30



VENTING THE RELIEF VALVE

The picture shows how a solenoid valve can be used to vent a cartridge relief valve.

The spring-offset, single solenoid directional valve is bolted onto the interface of the cartridge valve cover. When the solenoid is de-energized, the relief valve is vented to tank thru the solenoid valve's P and B ports. When the solenoid is energized the P port is blocked causing the cartridge relief valve to return to its pre-set pressure.

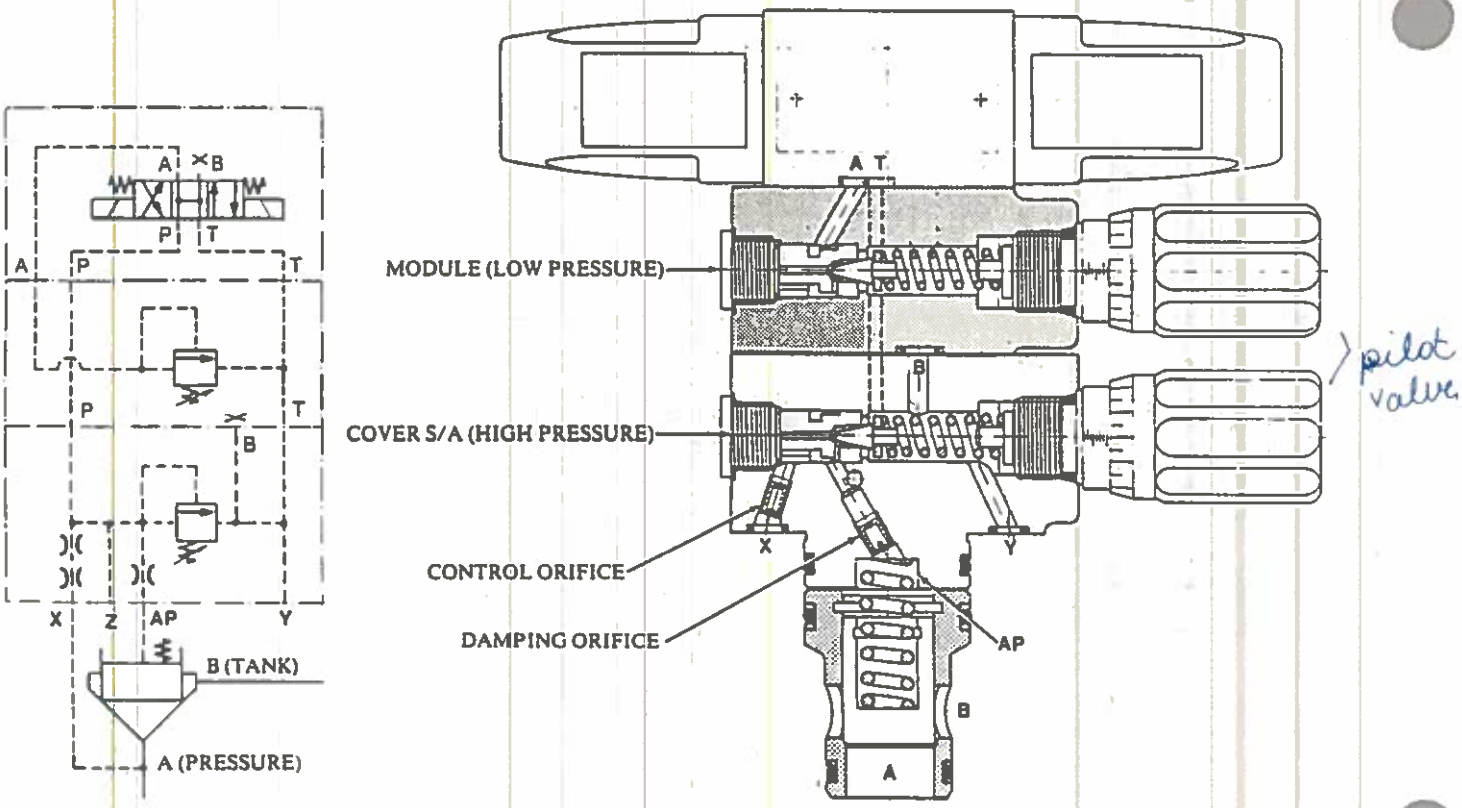


FIGURE NO. 31 DUAL PRESSURE SETTINGS PLUS VENTING

In this arrangement, a spring centered directional valve controls two relief valve pilot stages to provide two different relief pressures. Also, when the solenoids are de-energized, the relief valve is vented to tank. The Z port is a remote vent connection. Block the Z port if the remote vent feature is not used.

The high pressure setting is controlled by the pilot valve located in the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. At least a 10.3 bar (150 PSI) spread is required between the high and low pressure setting to prevent oscillation between the two pressure settings.

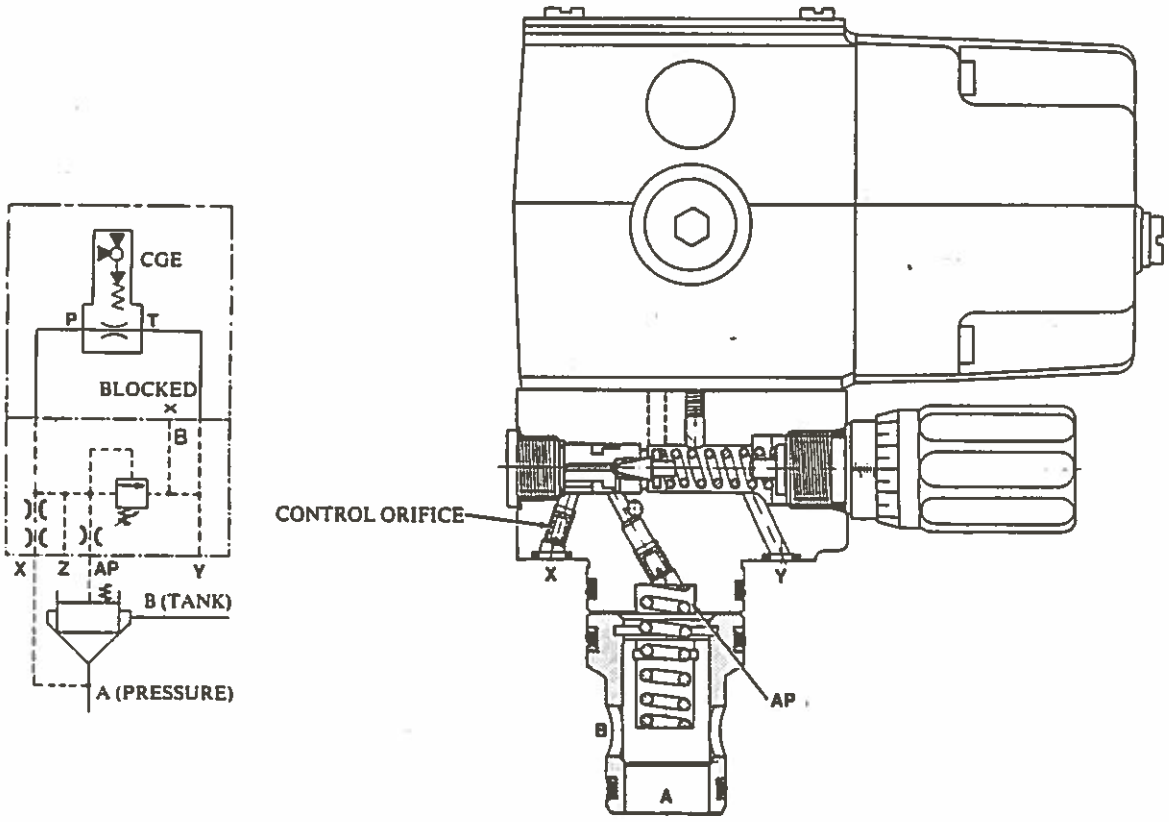


FIGURE NO. 32 ELECTRICALLY MODULATED RELIEF VALVE

The cartridge valve interface cover accommodates the CGE-Ø2-*-2Ø electrically modulated relief valve. This valve can be remotely controlled by a micro-computer or a regulated power supply with appropriate voltage and current control. As current increases, pressure drop across the CGE valve increases. This will cause the system pressure to increase proportional to current change up to the manually set pressure of the cartridge relief valve. That's because the pressure drop across the CGE valve cannot exceed the manual pressure setting of the cartridge valve.

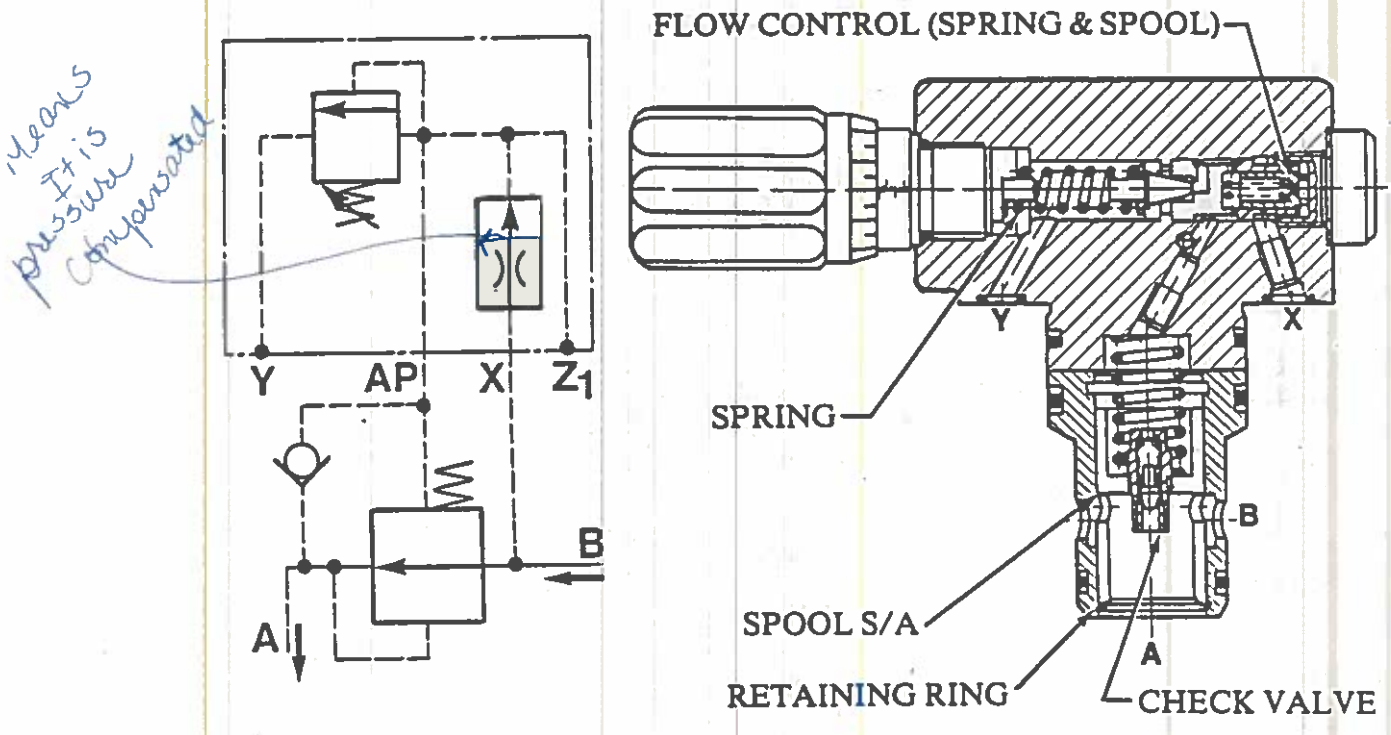


FIGURE NO. 33 PRESSURE REDUCING VALVE

The pressure reducing valve in the cartridge valve family operates in much the same manner as the traditional type of pressure reducing valve. Even its construction is similar. It has a pilot stage which consists of an adjusting screw, spring, poppet, and seat with integral flow control to limit flow through trhe pilot stage. It has a main stage which consists of a sliding spool, spring offset to the open position. Flow direction is only one way, from port B to port A.

FIGURE NO. 33 (cont'd)

In operation, the A port is connected to the load and the B port is connected to the pressure source The B and X ports are interconnected within the manifold. System pressure at B is fed to the X port and communicated through a pressure compensated flow control into area AP. This flow control in the cover limits flow to the pilot stage. The flow control spring and spool act as a hydrostat to control a variable orifice which holds a constant pressure drop across the fixed orifice.

Thus, there is a constant flow thru the pilot stage regardless of main system pressure at B port during the reducing valve operation.

The main stage spool is spring loaded to the open position with equal pressure at the top and bottom of the spool until load pressure increases to the pilot stage setting. With the pilot stage limiting the pressure at the top of the main stage spool and load pressure rising to equal the spring force plus the pressure on top of the spool, the spool will move up restricting the flow to the load. Thus, the maximum pressure at the load will be the pilot stage setting plus the spool spring force.

The valve can be vented by opening the Z1 port.

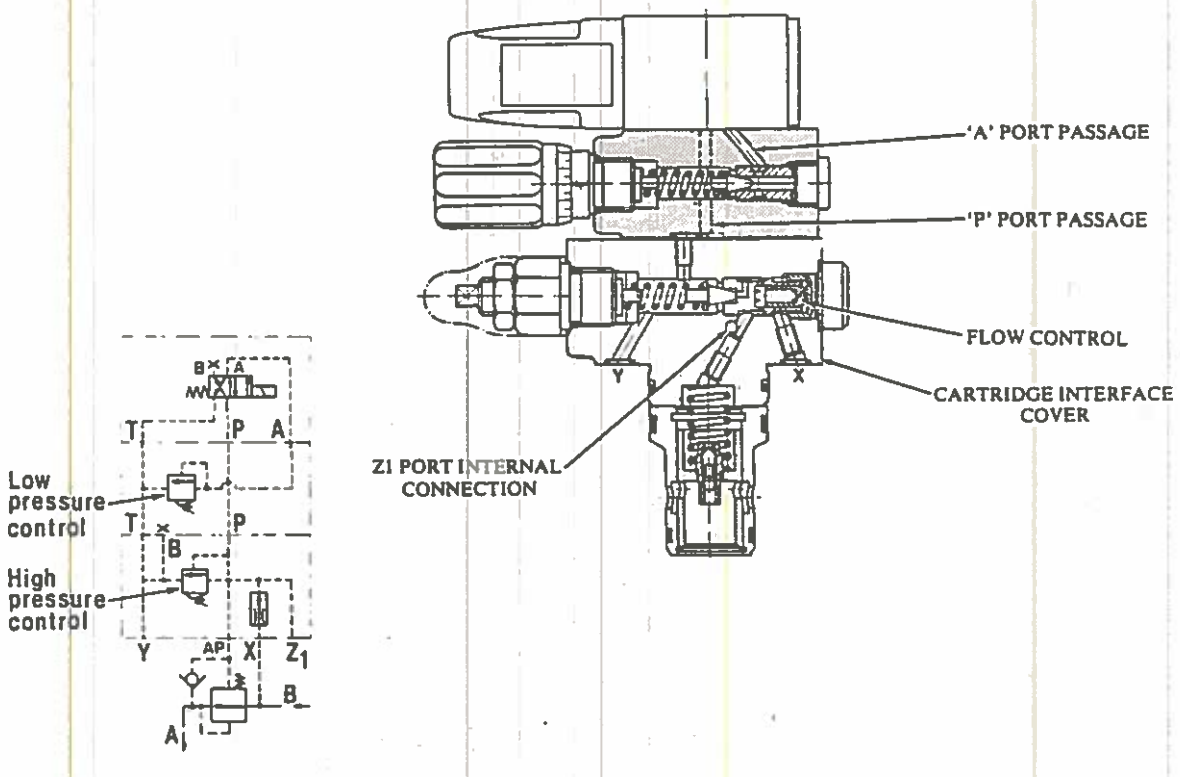


FIGURE NO. 34 PRESSURE REDUCING VALVE WITH HIGH AND LOW ADJUSTABLE SETTINGS BY ELECTRICAL SELECTION

In this valve assembly a left hand, spring offset directional valve controls two reducing valve heads and provides two different reduced pressures.

The highest pressure setting is controlled by the pilot valve located in the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. When the directional valve is in the spring offset condition (solenoid de-energized),

FIGURE NO. 34 (cont'd)

the high pressure setting is active. Provide at least 10.3 bar (150 PSI) spread between the high and low pressure settings to prevent oscillation between the two pressures.Use a standard spring offset valve (offset P to A) to have the low pressure setting functional in the spring offset condition. If a standard valve is used, check installation dimensions to make sure a physical problem does not exist. The standard valve's solenoid will be directed away from the adjuster mechanism.

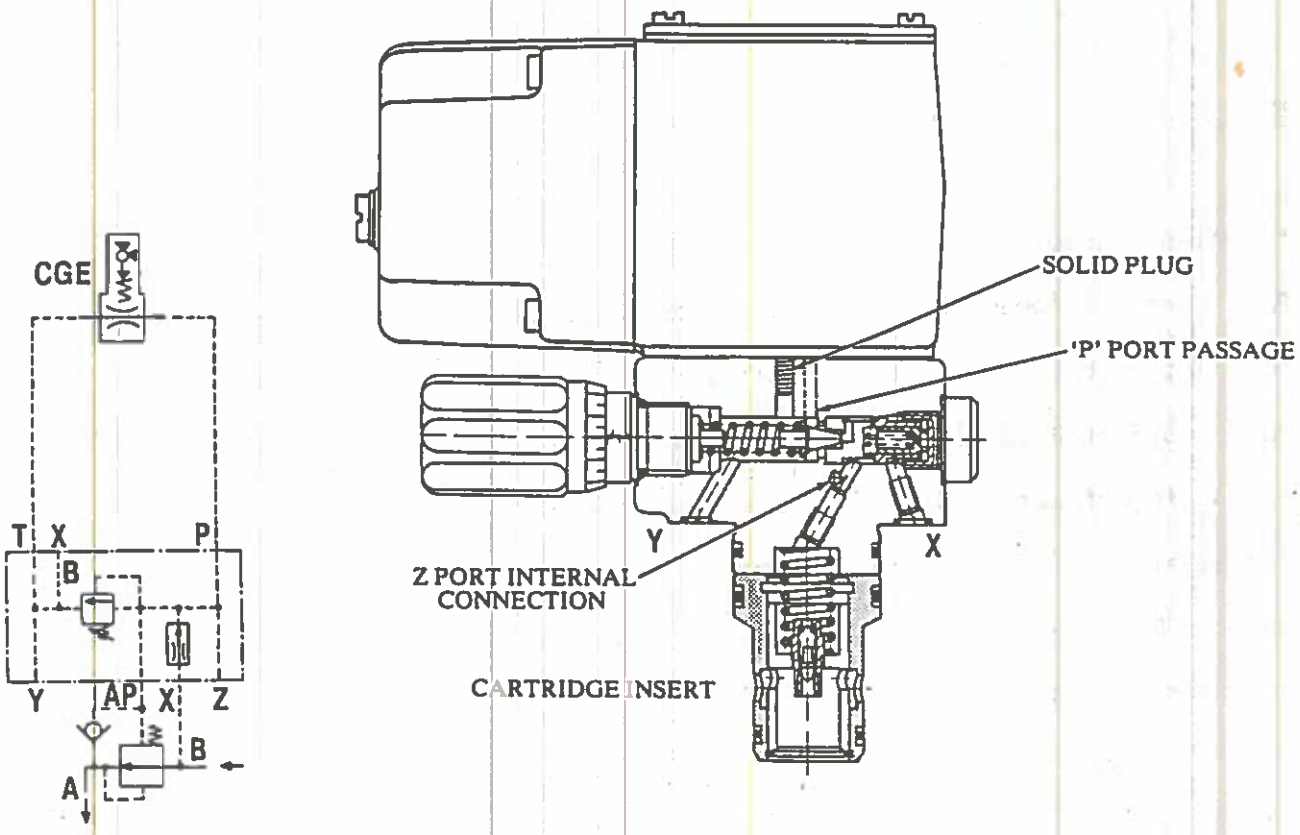


FIGURE NO. 35 ELECTRICALLY MODULATED PRESSURE REDUCING VALVE

FUNCTION

The cartridge valve interface cover accommodates the CGE-02-*-20 electrically modulated relief valve. This valve can be remotely controlled by a micro-computer or a regulated power supply with appropriate voltage and current control. As current increases, pressure drop across the CGE valve increases. This will cause the pressure reducing valve pressure to follow the CGE valve. The maximum setting of the cartridge valve is limited by the setting of the manual adjuster located in the cartridge valve section.

34

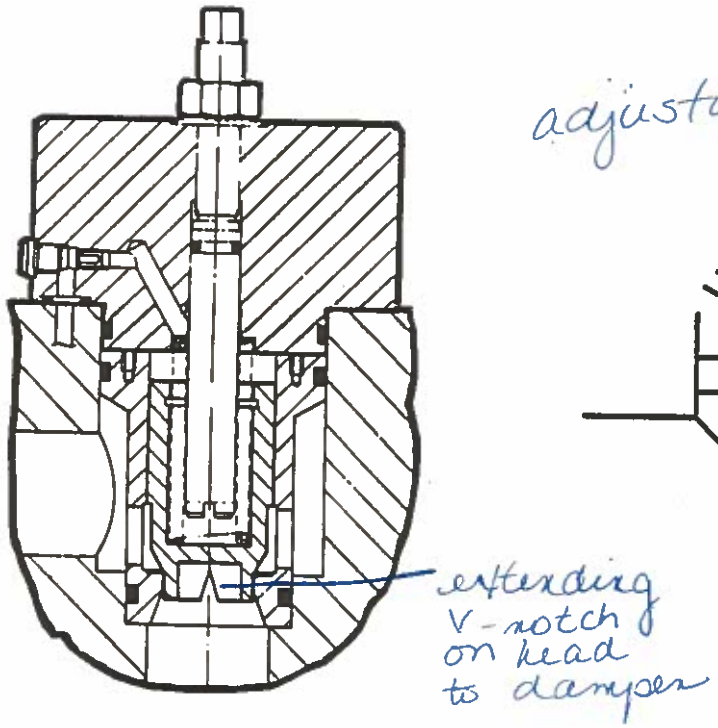


FIGURE NO. 36 FLOW CONTROL VALVES

Flow control valves fall into two basic categories: pressure compensated and non-pressure compensated. The latter are used where load pressures remain relatively constant and feed rates are not critical. They may be as simple as a fixed orifice or an adjustable needle valve.

A cartridge valve with stroke adjustment cover and notched metering poppet provides non-pressure compensated control of flow rates in a manner similar to a needle valve. However, the cartridge valve has the additional feature of being able to be turned on or off without changing the throttle setting.

FIGURE NO. 36 (cont'd)

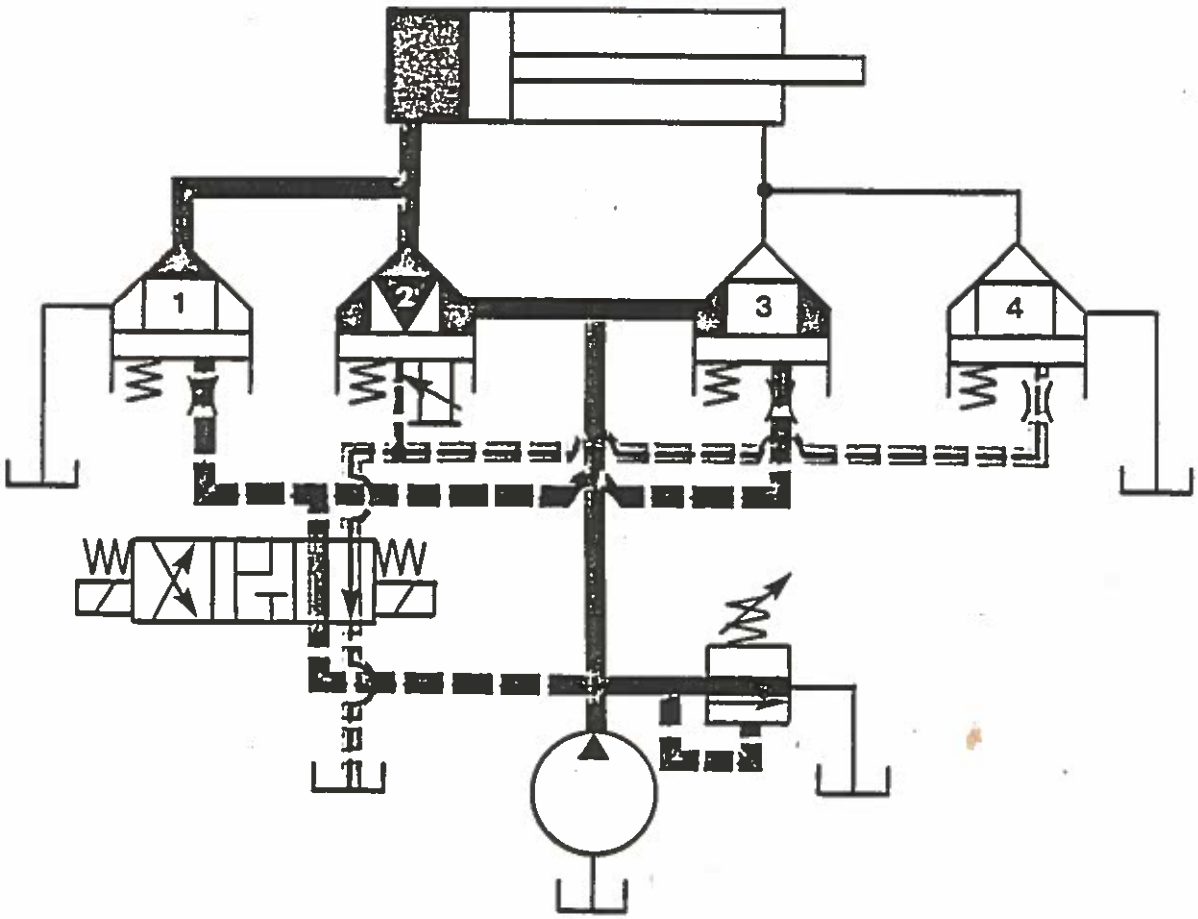
The stroke adjustment cover contains a pin which extends into the cartridge spring chamber. The pin forms a stop to limit the distance the poppet can move off its seat. The pin position is adjusted by a screw which itself is available in four configurations; plain screw adjustment, screw adjustment with cap, micrometer knob, and micrometer knob with key lock.

To indicate that the cover has the adjustable stroke feature the graphical symbol includes a rectangle to show manual operation and an arrow to show adjustability.

To provide good control of the flow through a cartridge valve the stroke adjustment cover should be used in combination with a companion poppet. Designed for use with a standard 1:2 area ratio insert, the poppet has a v-notched skirt which has better metering characteristics than a standard poppet. The trade-off to this is a substantial reduction in the flow rate at 5 bar differential pressure.

35

FIGURE NO. 37 METER IN CIRCUIT



Here is an application of the stroke adjustment cover with v-notched metering poppet. It controls the speed of the piston by metering the flow of oil into the cap-end of the cylinder. This is a non-pressure compensated meter-in system.

If the piston is to control an overhauling load it is necessary to limit the flow rate of the oil leaving the rod-end of the cylinder. To do that, put the stroke adjustment cover on valve number 4 instead of valve number 2. Also, install a shuttle valve in the supply line to the solenoid valve. Connect the shuttle valve to both the rod-end port of the cylinder and to the pump. This assures enough pressure to keep valve 3 closed when the piston is extending.

BY-PASS TYPE FLOW CONTROL

For more accurate control of flow rates, pressure compensated flow controls may be constructed from standard cartridge valve components.

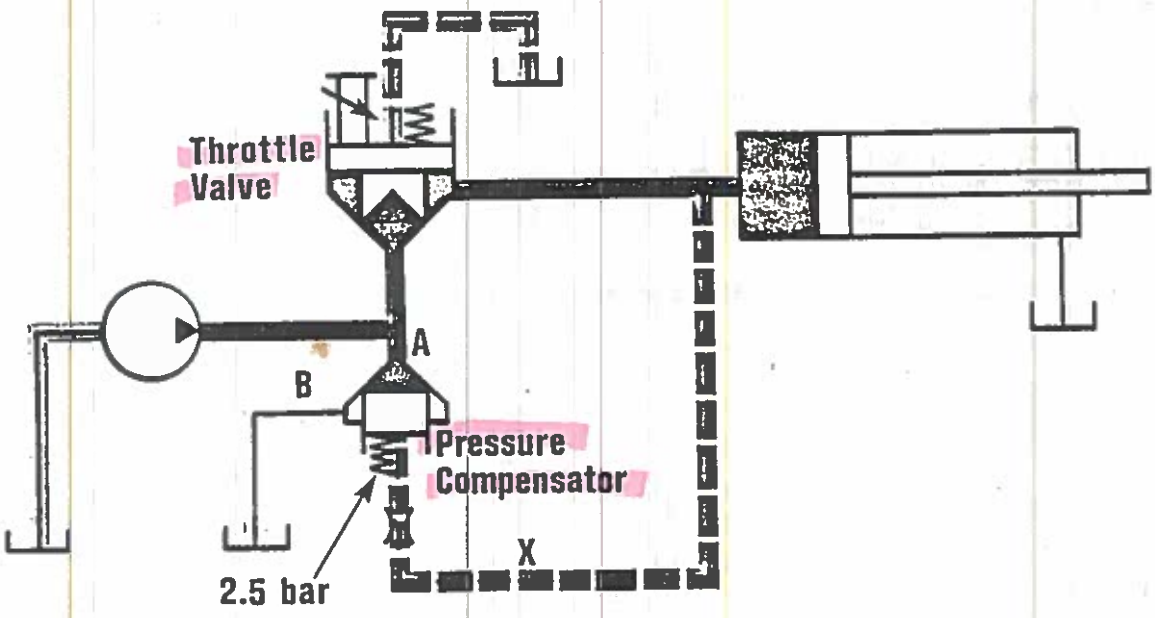


FIGURE NO. 38 BY-PASS TYPE FLOW CONTROL

A by-pass type flow control holds the adjusted flow rate constant by keeping the differential pressure across the throttle constant regardless of load pressure.

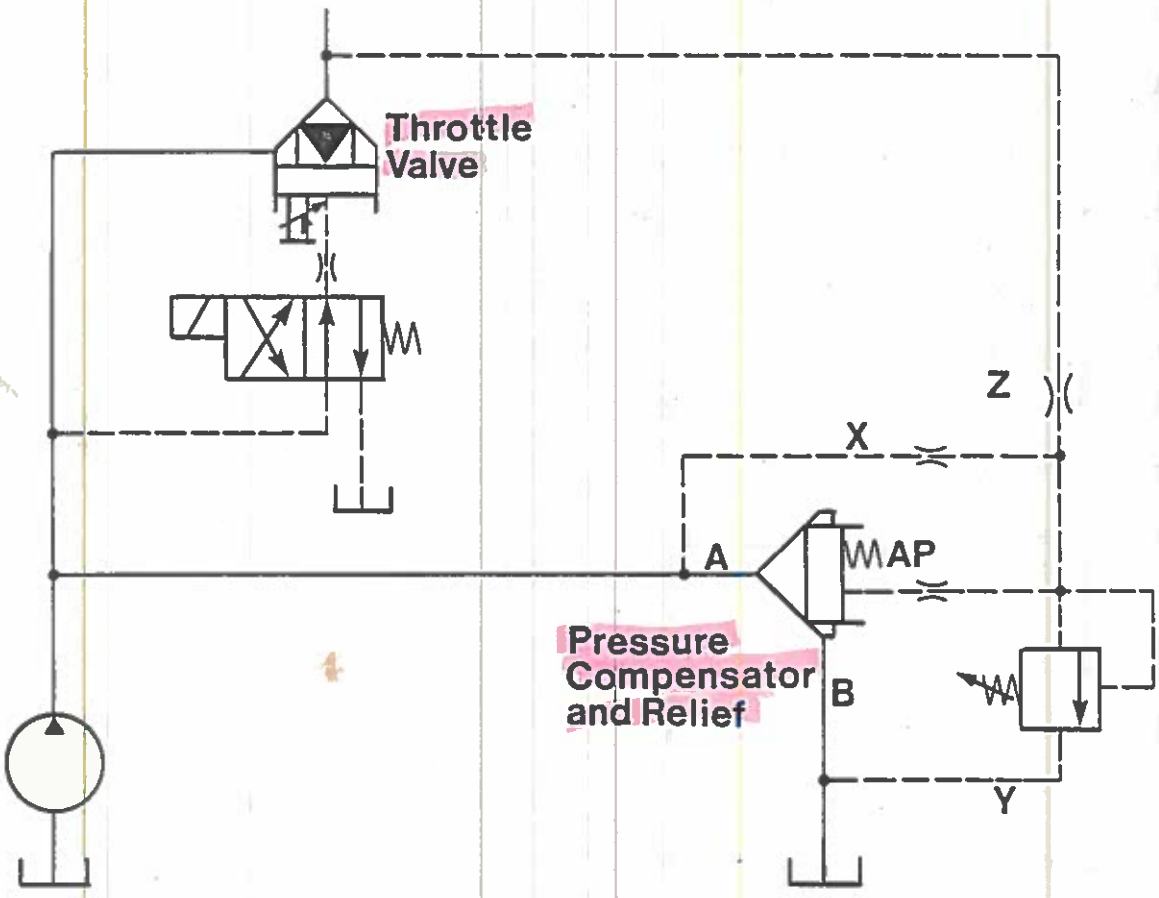
Pressure compensation in a cartridge type, by-pass flow control system is provided by a 1:1 area ratio poppet and standard cover as shown in this figure. The flow through the throttle in the cartridge valve that has a stroke adjustment cover and 1:2

FIGURE NO. 38 (cont'd)

throttling poppet generates a pressure drop. This pressure drop is sensed across the 1:1 insert at the A and X ports of the pressure coompensator. When the pressure drop equals 2.5 bar (the spring force level) the poppet opens and by-passes excess oil from the pump to tank. An increase in load on the cylinder would increase the pressure at the X port. This raises the pressure level upstream of the throttle an equal amount thereby holding constant the pressure drop across the throttle and thus holding constant the flow thru the valve.

Pressure at the pump will be 2.5 bar higher than load pressure. No maximum pressure limit is provided by this type of flow control. The next figure shows how to limit the maximum pressure.

FIGURE NO. 39

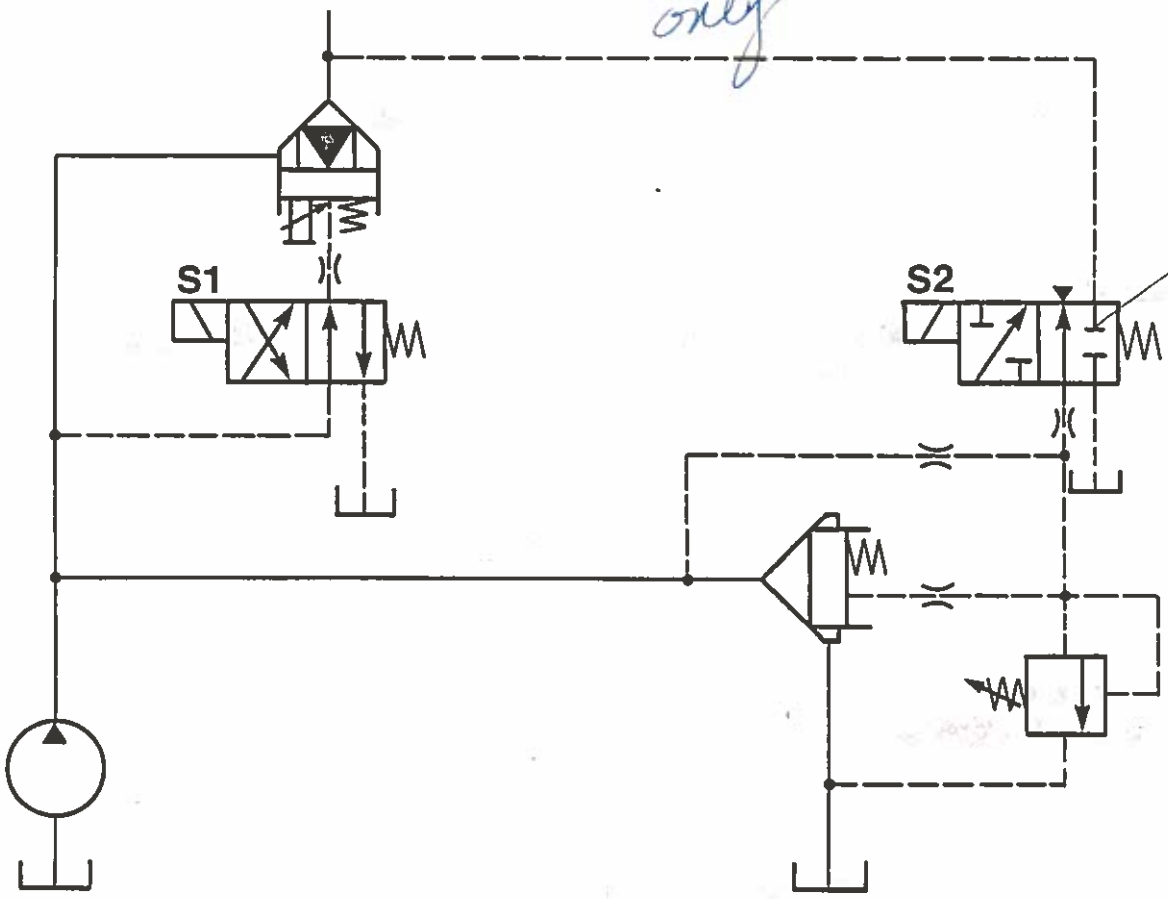


Maximum pressure limitation in a by-pass type, pressure compensated flow control can be provided by replacing the standared cover of the 1:1 insert pressure compensator valve with a relief valve cover. The pilot relief valve will limit pressure in the AP area of the poppet whether it is on the load side of the throttle or on the pump side. When the throttle insert is closed, pilot flow would be from A port through the orifice in the X passage and over the pilot relief valve thereby limiting the maximum system pressure. If the throttle is open and the cylinder is moving, the load pressure plus throttle valve restriction pressure establishes the system pressure.

used resistive load only

38

FIGURE NO. 40



In either condition flow through the pilot passage is from the A port through the X port to the connection of the load sensing passage downstream of the throttle. This flow would cause the cylinder to creep if the throttle was closed with the cylinder Piston creep can be elimintaed by installing a spring offset directional valve in the load sensing line to prevent flow when the throttle poppet is closed.

The by-pass type flow control and relief valve provides accurate flow control plus it saves horsepower because pump pressure is never more than 2.5 bar over load pressure.

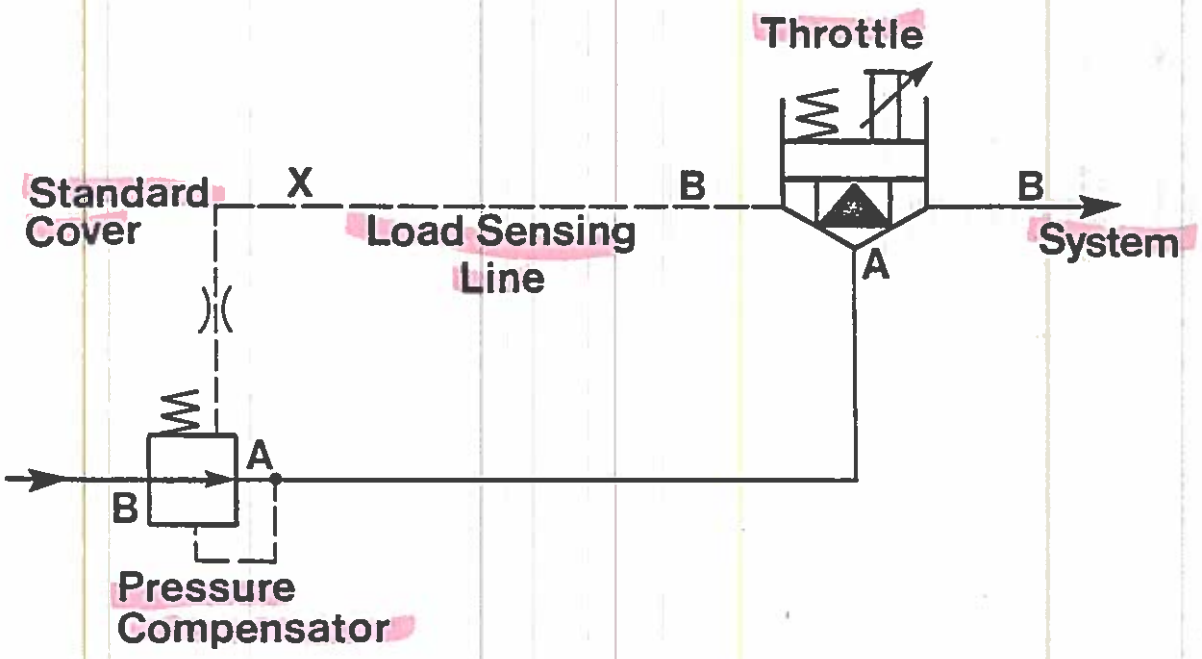


FIGURE NO. 41 RESTRICTOR TYPE FLOW CONTROL

When a reducing valve insert with standard cover is installed in series with the 1:2 metering cartridge with stroke adjustment cover to act as a compensator, the pressure difference across the metering poppet (throttle) is held constant. (The pressure difference is determined by the spring force in the reducing valve). The flow rate through the throttle will therefore be held constant. The flow rate through the throttle may be changed by varying the stroke adjusting screw position.

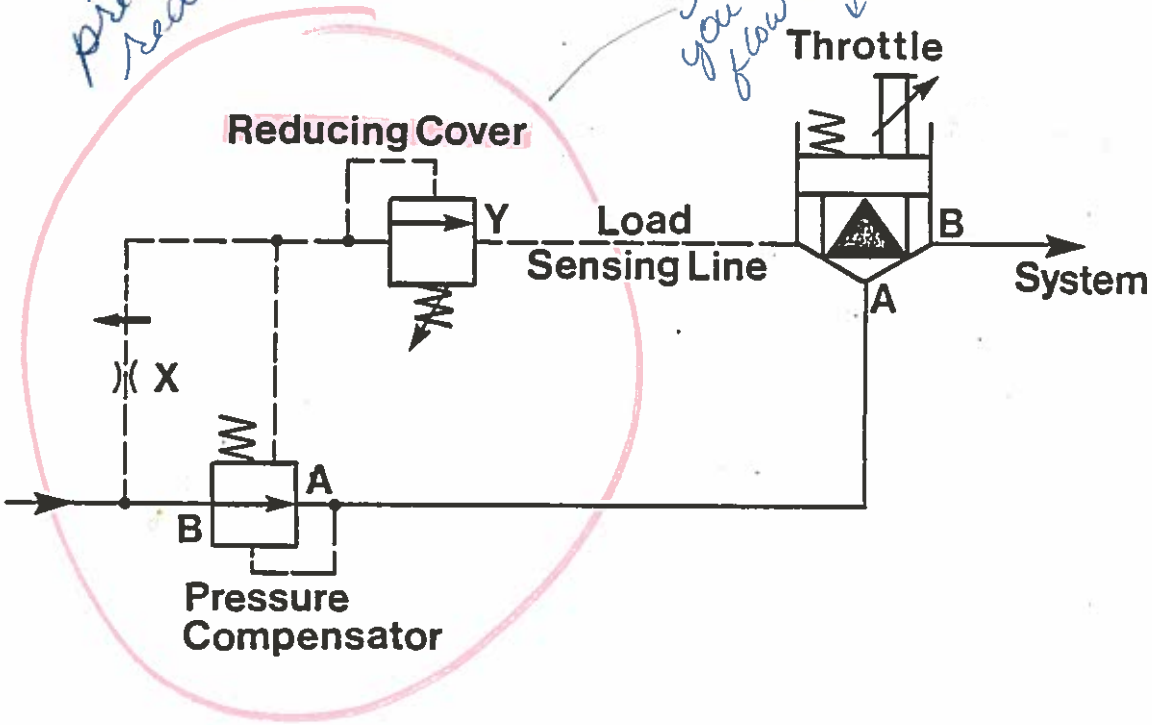


FIGURE NO. 42

The pressure difference across the throttle of the restrictor type flow control may be varied by replacing the standard cover used with the reducing insert, with a reducing valve cover. The drain port (Y) of the reducing cover must be connected downstream from the throttle in order to sense the load pressure. The pressure drop across the throttle is now determined by the setting of the reducing cover pilot stage plus the spring value of the reducing insert. The flow rate through the valve may now be adjusted by varying the reducing cover spring setting and/or the setting of the stroke limiter. Increasing the reducing cover spring force provides higher flow capability of the throttle. The restrictor type flow control may be used in meter-in, meter-out or bleed-off circuits.

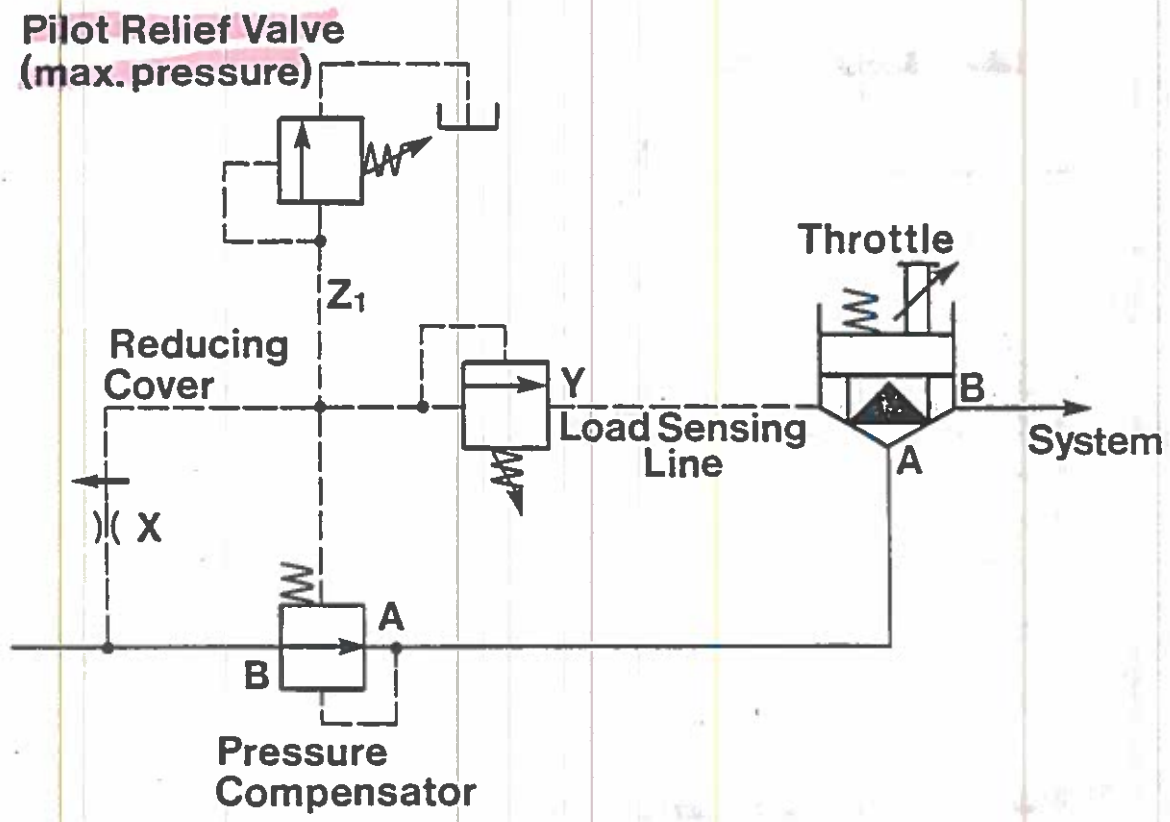


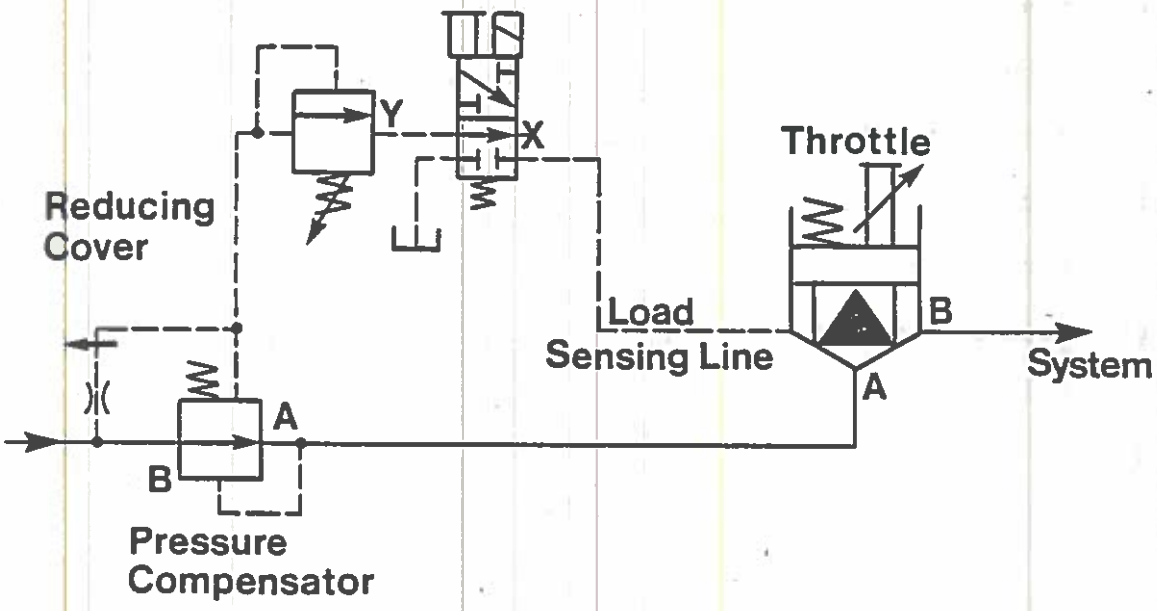
FIGURE NO. 43 FLOW CONTROL AND REDUCING VALVE

The cartridge restrictor type flow control may also be used to limit the maximum pressure downstream from the throttle by the addition of a pilot relief valve. The flow control operates the same as in figure 40, except that the relief valve now limits the maximum pressure in the spring chamber of the reducing insert, thereby allowing the valve to operate as both a flow control and a pressure reducing valve when applied as a meter-in valve.

FIGURE NO. 43 (cont'd)

Remember that unlike the standard resistor flow control valve, the cartridge version is also used as one of the flow paths of a directional valve. When the throttle cartridge is piloted closed to block flow to the actuator, it is possible for the actuator to creep due to pilot flow in the load sensing line. Across the throttle there exists a pressure difference due to the higher pressure at the inlet of the compensator protion of the valve. There will still be a small flow (determined by the pressure compensated flow control in the reducing cover) across the reducing cover pilot stage and into the actuator.

FIGURE NO. 44



To prevent this unwanted flow, a spring offset directional valve may be installed in the load sensing line between the reducing cover and the outlet port of the throttle cartridge valve as shown in this figure.

The spool is hydraulically balanced by means of a drilled passage which connects the A port area to the annulus area on the top of the spool. A spring biases the spool to the closed position and so the solenoid force only has to overcome the spring force.

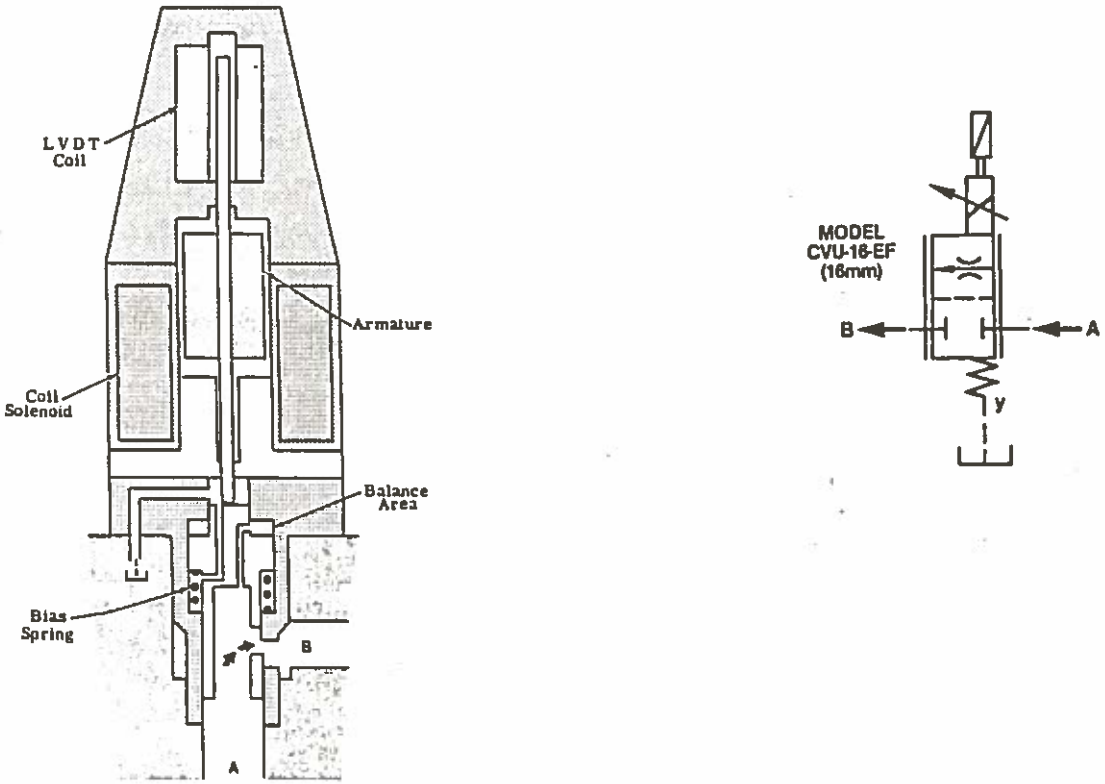


FIGURE 45

The solenoid is used with a closed loop electronic control whereby an input signal continuously opens the valve until the reguired amount of opening is achieved, when the LVDT feedback signal coincides with the input signal. The valve opening is therefore proportional to the solenoid input signal. In its basic form, the valve is non-pressure compensated, but may be incorporated with a hydrostat or flow sensor as shown in the flow control circuits in this section by replacement of the throttle stroke adjust cover and insert.

Larger cartridge sizes use a two stage arrangement as shown in figure 46. In this case the proportional solenoid acts directly on a spring loaded pilot spool. A pilot flow is taken from the inlet (A) port of the valve and is bled to tank via the port that connects to the top of the main poppet.

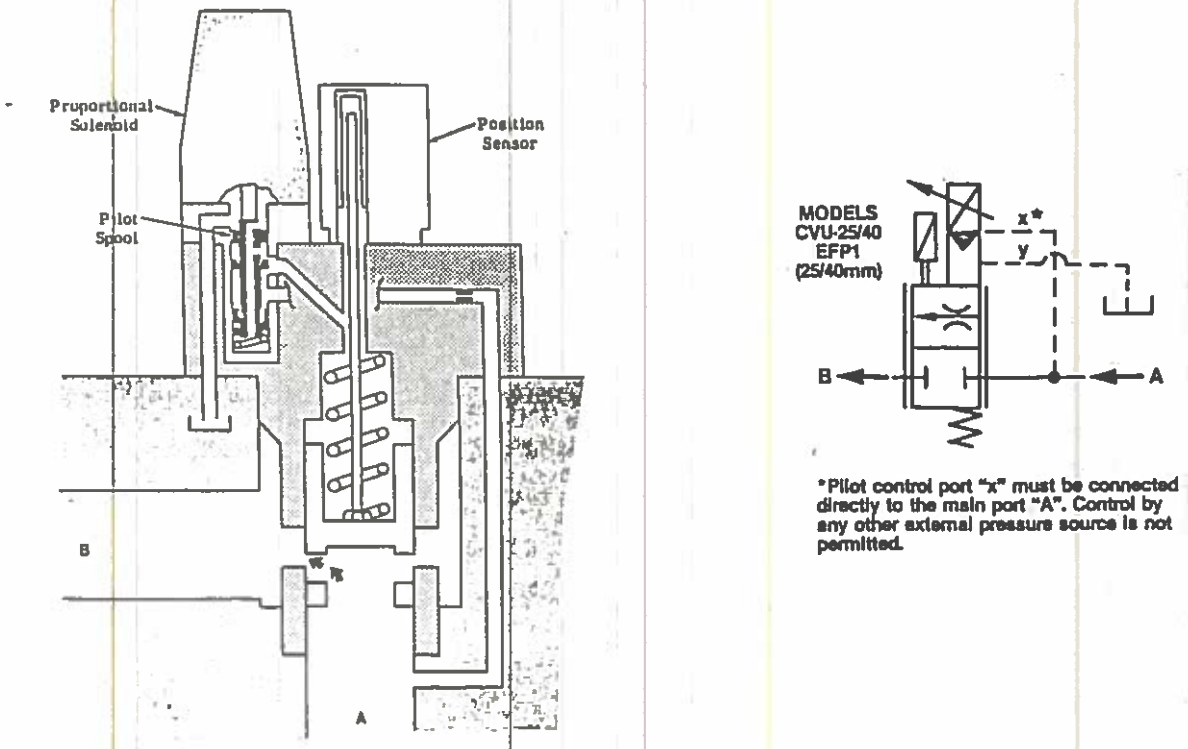


FIGURE 46

With zero signal to the solenoid, the spring pushes the pilot spool to the fully up position. This blocks the pilot bleed flow so full inlet port pressure is applied to the top of the main poppet. With the same pressure top and bottom of the main poppet, its spring pushes it to the fully closed position. As a signal is applied to the solenoid, the pilot spool moves down. This opens up a bleed path for the pilot flow and reduces the pressure

42

on the top of the main poppet. This pressure drop causes the poppet to lift, opening the main flow path through the valve until the feedback signal from the position sensor coincides with the input signal to the solenoid. The valve then reaches a steady state position at an opening determined by the input signal.

The pilot supply for the valve must be taken directly from the A port, and be a minimum pressure of 10 bar.

As with the direct acting version, the valve is non-pressure compensated and must be used in conjunction with either a hydrostat or flow sensor if pressure compensation is required.

ELECTRONIC CONTROLLER FOR THROTTLE VALVES

The electronic controller is a unit designed specifically for the control of a proportional solenoid valve, with electrical position feedback.

Connection Diagram

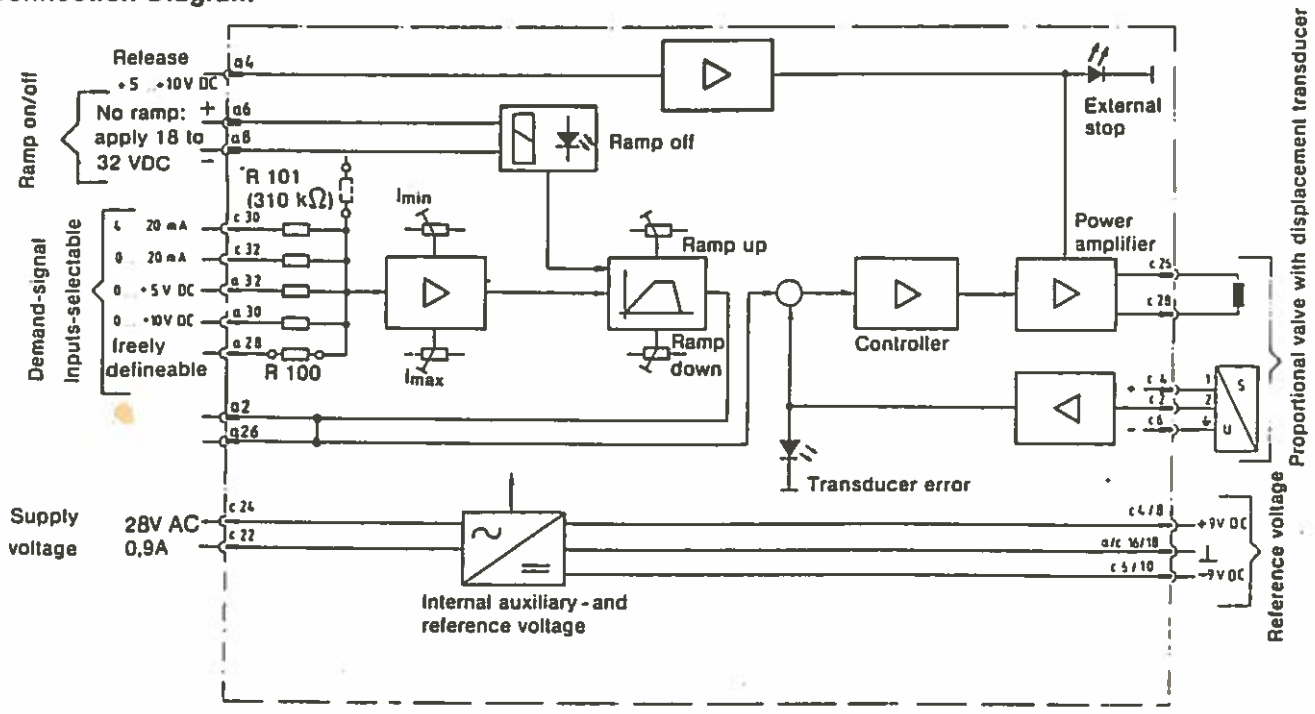


FIGURE 47

The command signal can be provided by an external potentiometer, an external voltage source, or by switching internal relays to select any combination of four internal potentiometer settings. With the internal pots set at 1, 2, 4, and 8 volts, up to a total of 16 discrete (binary code) voltage levels can be selected.
Adjustable internal ramp potentiometers provide independent control of acceleration and deceleration rates within the range of 50 to 350 ms.
Minimum response of the stroke sensor and the start-up point of the output signal can be selected by adjusting the "ZERO BALANCE"potentiometer. The upper limit of input current can be adjusted via the "MAX" potentiometer.

44

PRESSURE CONTROL CIRCUITS

The circuits in this section are examples of pressure control systems. They show the basic control for instruction purpose only. Changes in circuitry may be required to satisfy all requirements of an application.

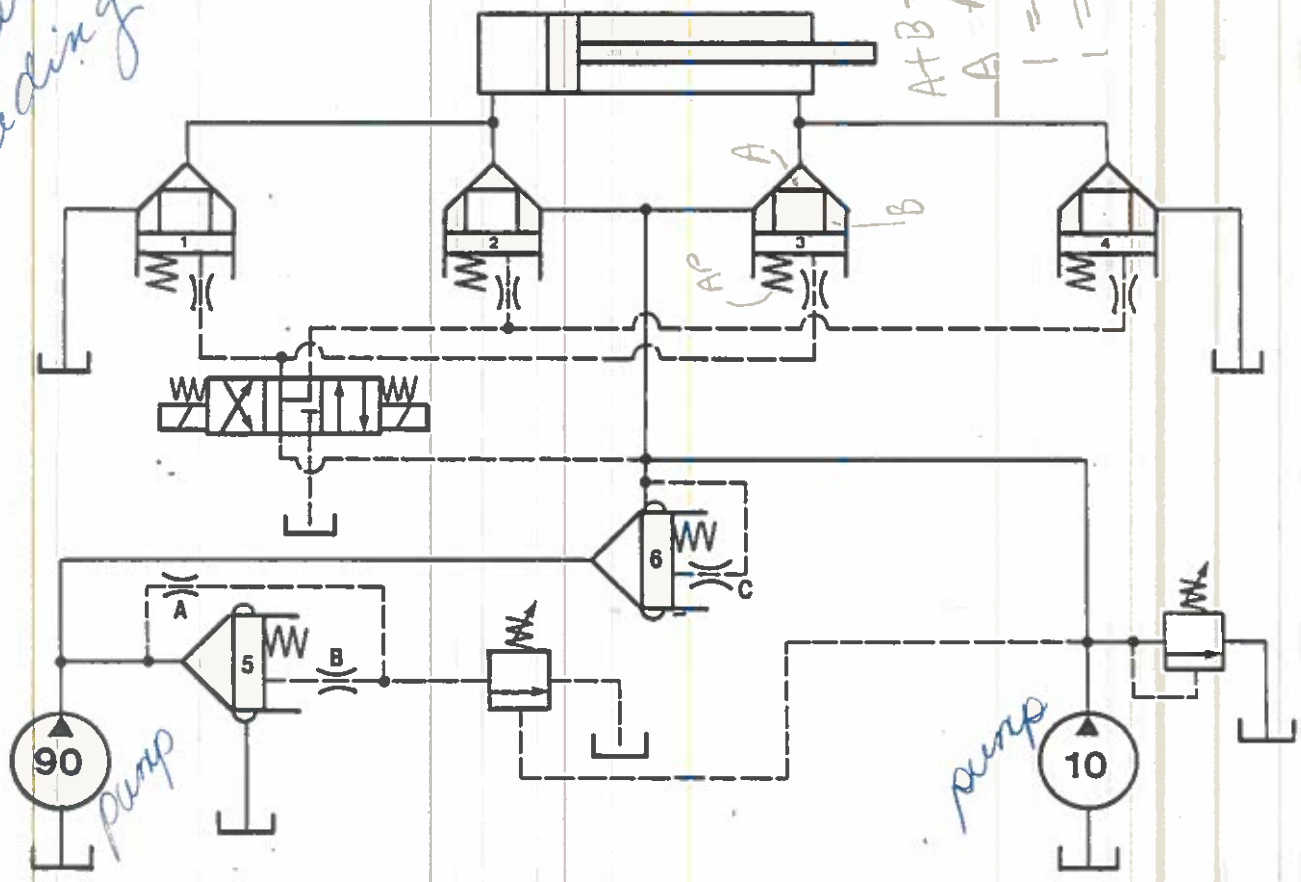


FIGURE NO. 49 UNLOADING

This high/low circuit shows a typical unloading valve application. A 1:1 cartridge with a 2 bar spring and a standard cover is used as an unloading valve (Valve #5).A small unloading valve, is used to control the operation of the cartridge unloading valve. The cylinder is controlled by a typical 4-way cartridge directional valve arrangement. Another 1:1 cartridge insert with a 2 bar spring is employed as a check valve (Valve #6) to prevent the output of the small pump from dumping through the unloading valve.

During the high flow, low pressure phase of operation, the pressures at the A port and on area AP of the unloading valve will be equal and the spring will hold the poppet closed. The large volume pump

45

FIGURE NO. 49 (cont'd)

delivery is directed through the check valve (#6) to join the smaller volume pump and extend the cylinder. When the cylinder goes into the work cycle where high pressure but low flow is required, the pressure rise at the small volume pump outlet is sensed in the pilot port of the unloading valve. The unloading valve will be set to open approximately 150 PSI above the circuit's low pressure requirement. The pressure during the low flow, high pressure phase of operation must be high enough to hold the unloading valve pilot wide open. This in turn will drain the spring chamber of valve #5 to tank. With the spring chamber drained to tank the large volume pump will work just hard enough to overcome valve #5's spring (2 bar). The orifices at B and C are used to control the opening and closing speeds of their poppets, thereby reducing the possibility of hydraulic shock.

Note that the unloading valve used here is limited to a maximum of 3000 PSI. This limits the maximum operating pressure of the cartridge valve to 3000PSI. A pilot valve which would permit operation of the unloading valve at pressures higher than 3000 PSI would be a single solenoid, spring-offset directional valve. The solenoid would be controlled by a pressure switch sensing the pressure at the outlet of the small volume pump. The pressure switch would be set at a pressure slightly above the pressure requirement of the high volume phase of operation. In this manner the maximum, 5000 PSI, pressure capability of the cartridge valves could be utilized.

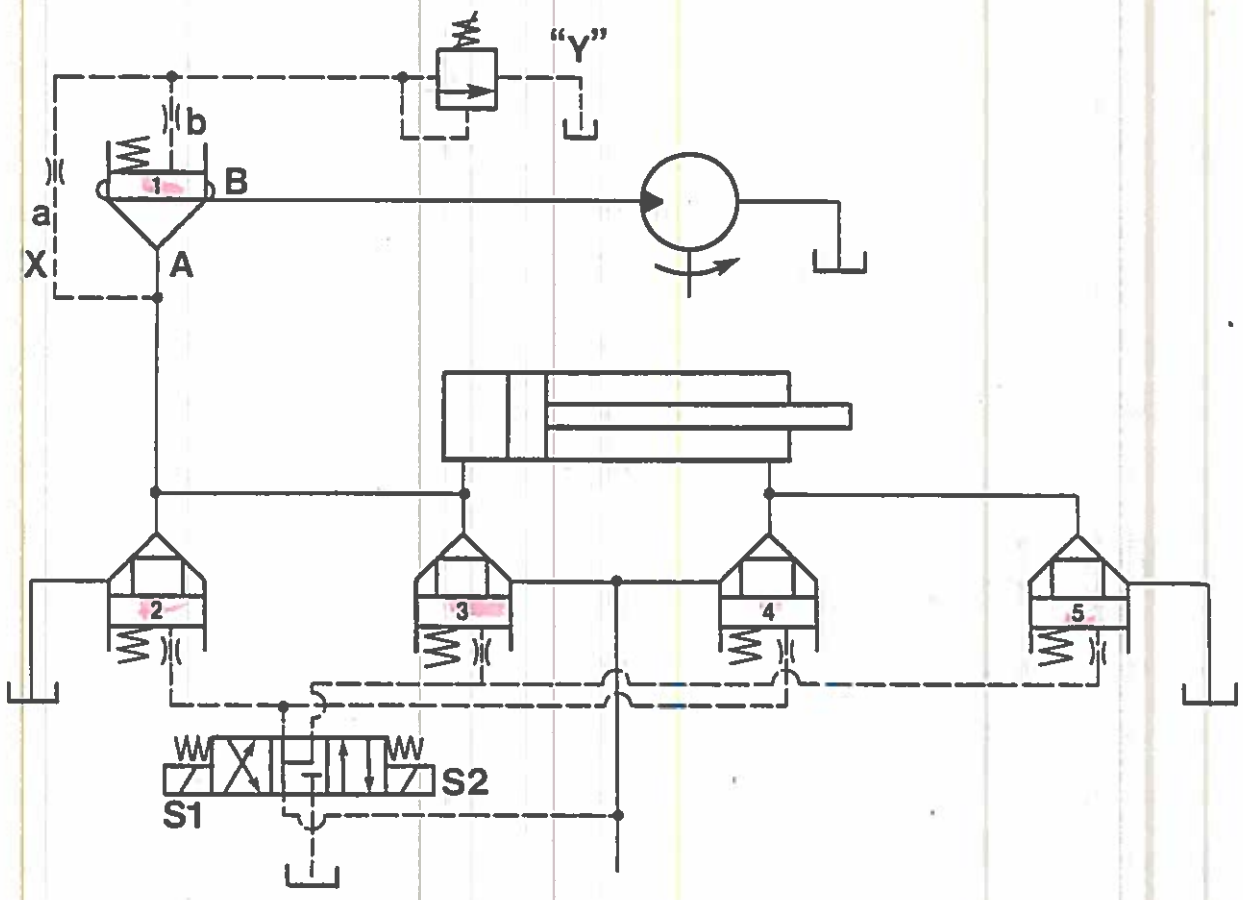


FIGURE 50

SEQUENCE

The sequence of events in the circuit shown are that the cylinder extends before the motor turns. The motor is unidirectional and must be stopped while the cylinder is retracting. The 4-way valve controlling the cylinder is a standard 4-way cartridge valve arrangement. The sequence valve consists of a 1:1 insert with a 2 bar spring and a relief valve cover which is externally drained thru the Y port.

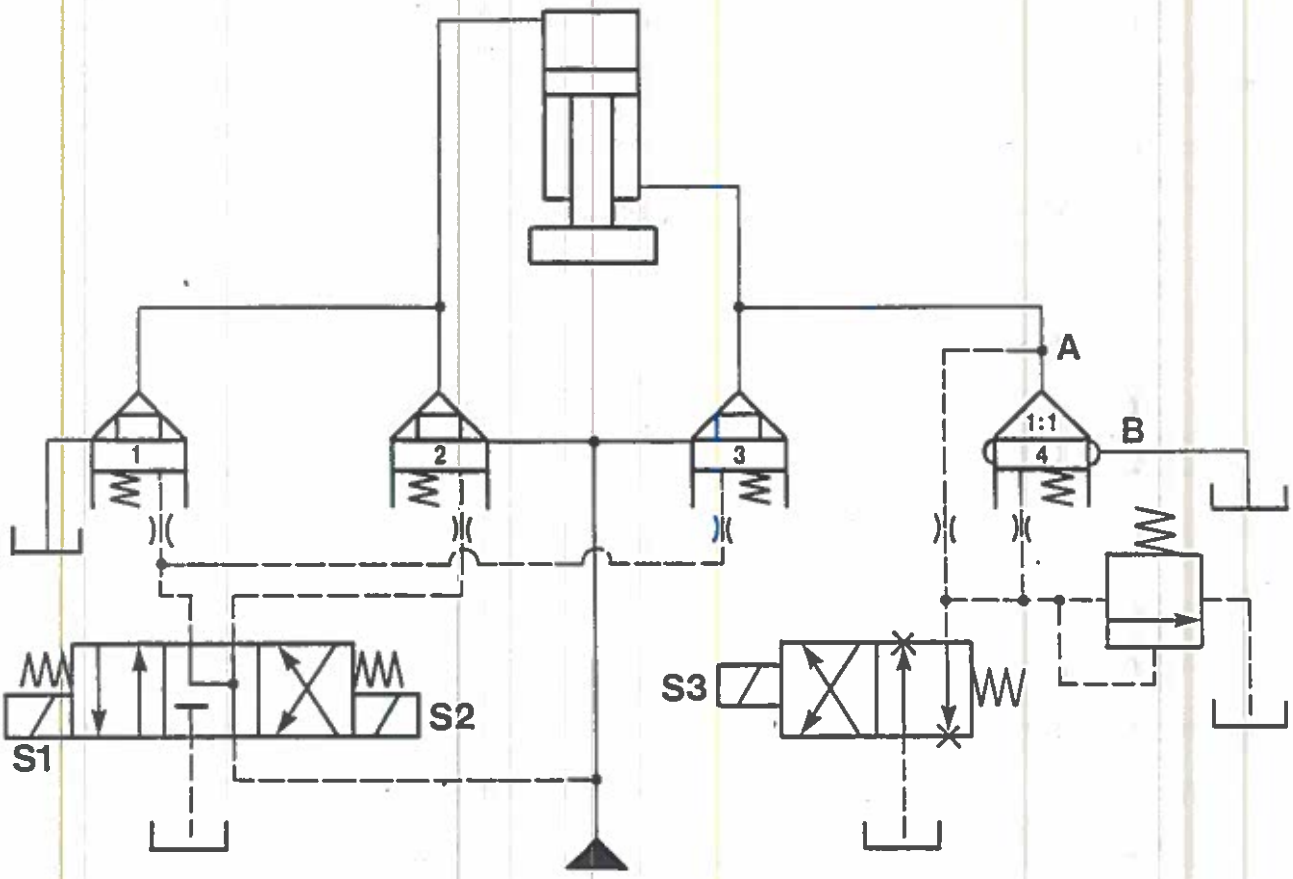
46

FIGURE NO. 50 (cont'd)

The operation of the sequence valve is as follows: Flow through the sequence valve to the motor is from port A to port B. As in any sequence application, the sequence valve is set higher than the pressure needed for the first operation. In this circuit a drilled passage in the manifold connects the X port of the relief valve cover to the A port of the insert. When the cylinder reaches the limit of its travel the pressure in the spring chamber of the sequence valve rises till it reaches the relief valve setting. When it exceeds that setting the cartridge valve poppet opens, allowing flow to the hydraulic motor. During this phase of the operation the sequence valve insures a minimum pressure at the cap end of the cylinder - but if the rotating load increases, causing the pressure at the inlet of the motor to increase, then pressure at the cap end of the cylinder will also increase. The pressure at both actuators will be limited by the main system relief valve (not shown).

The orifice at 'b' is used to control the opening and closing rate of the poppet to limit system shock.

708



COUNTERBALANCE

Counterbalance valves are pressure control valves. They are included in hydraulic systems in which back pressure is required to prevent a load from falling. A typical counterbalance circuit is shown here. This circuit controls the main cylinder of a forming press. This type of press has a very heavy platten fastened to the piston rod of the down acting cylinder. To prevent the platten from falling freely during the "close" portion of the press cycle a counterbalance valve is included in the circuit.

47

FIGURE NO. 51 (cont'd)

Valve #4 has a 1:1 area ratio, a 2-bar spring, a relief valve cover and is controlled by a 2-position pilot valve. As shown in the drawing the AP area of valve #4 is connected to its A port. It is also connected to the pressure port of a pilot relief valve and to one of the cylinder ports of a spring offset solenoid valve.

The pilot relief valve that is connected to #4 should be adjusted so that it will open 50 to 100 PSI above the pressure in the rod end of the cylinder. With solenoids S1, S2, and S3 de-energized, all four of the cartridge valves will be closed; numbers 1, 2, and 3 by pilot pressure. Number 4 will be closed because its 1:1 poppet has the same pressure on both sides. Its 2-bar spring holds it closed.

To raise the platten energize solenoid S1, this opens the AP areas of #1 and #3 to tank. Oil from the pump will open #3 and raise the platten. Oil exiting the cap end of the cylinder will push open #1 and go on to tank. Number 2 will stay closed because pilot pressure from the pump is still acting on it. Number 4 will stay closed because the pressure on its A and AP area, the two areas are equal and the 2-bar poppet spring has enough force to hold the poppet on its seat.

To lower the platten energize only solenoid S2. This opens the AP area of #2 to tank and holds pilot pressure on both #1 and #3. Oil from the pump acts on the B area of #2, lifts the poppet off its

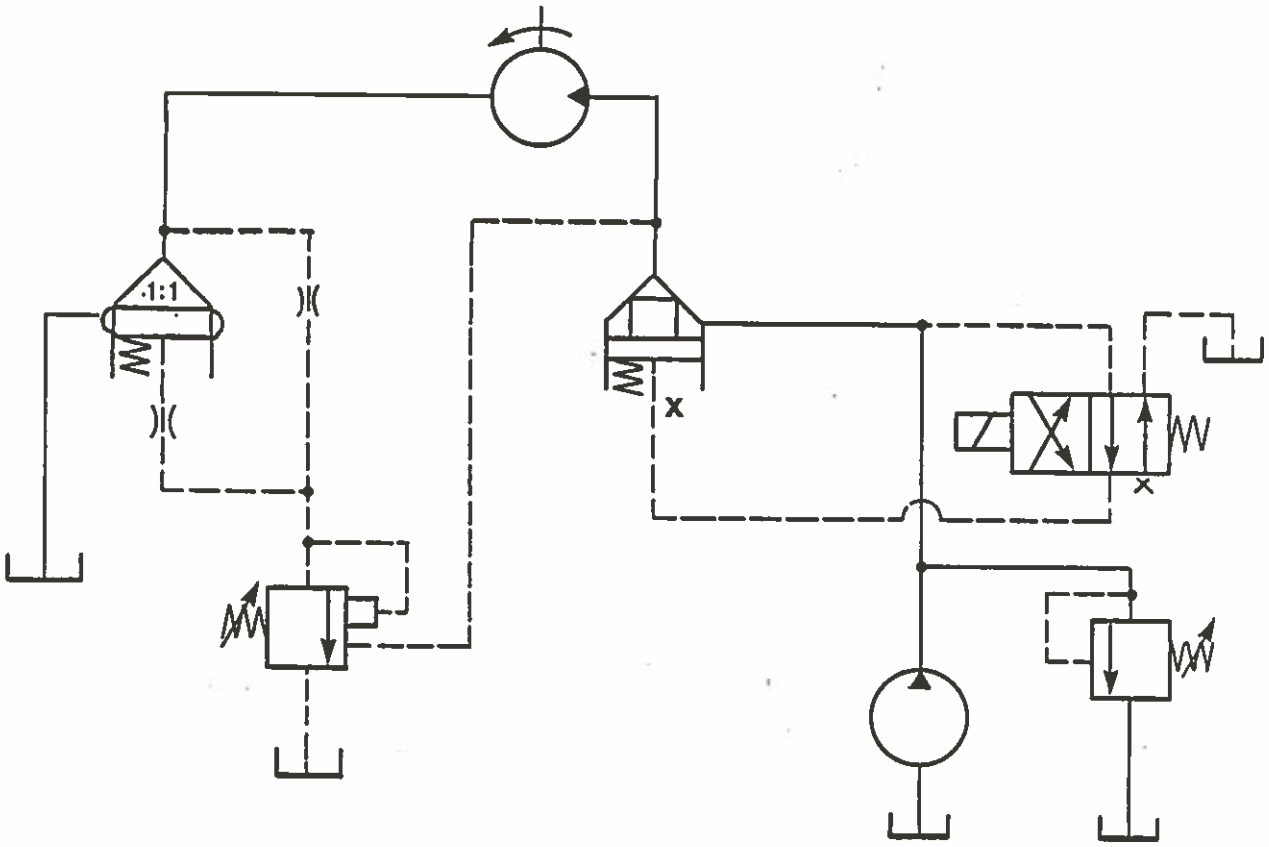
FIGURE NO. 51 (cont'd)

seat and flows into the cap end of the cylinder. However, the platten will not lower because #4 is still closed and it will stay closed until either solenoid S3 is energized or the pilot relief valve opens. The weight of the platten plus the force of the oil being pumped into the cap end will raise the pressure in the rod end until the pilot relief valve opens. Ths oil passing through the pilot relief valve must also squeeze through the orifice between the A and AP portions of #4. This means that the pressure on the A side of the orifice will be higher than that on the AP side. As the flow rate through the relief valve increases the pressure differential across the orifice increases until it becomes large enough (about 2 bar) to overcome the spring holding the poppet closed. Oil can now flow from the A to B ports of #4 and the platten will lower but not at a rate faster than the pump dictates. As long as solenoid S3 is not energized, the relief valve will maintain enough pressure on the rod end of the cylinder to prevent the platten from falling freely.

As soon as the platten reaches the work piece it is necessary to remove the back pressure on the rod end of the cylinder in order to exert full force during the pressing operation. This is done by energizing solenoid S3. This opens the AP area of valve #4 to tank. The only pressure needed to open #4 will now be that required to overcome the poppet spring about 2 bar.

48

FIGURE NO. 52



BRAKE CONTROL CIRCUIT

The cartridge insert used in the brake valve application employs a 1:1 ratio metering poppet, a standard cover, and a P type pilot pressure control valve which contains a external pilot control. A 1:2 insert is used to start and stop the motor by permitting or blocking fluid flow to the motor. This cartridge is controlled by the solenoid controlled directional valve. To start the motor, energize the directional valve, this drains the cartridge spring chamber to tank permitting pump flow to the motor. The pressure to accelerate the motor is communicated to the pilot valve shifting its spool and thereby draining the spring chamber of the main stage of the brake system.

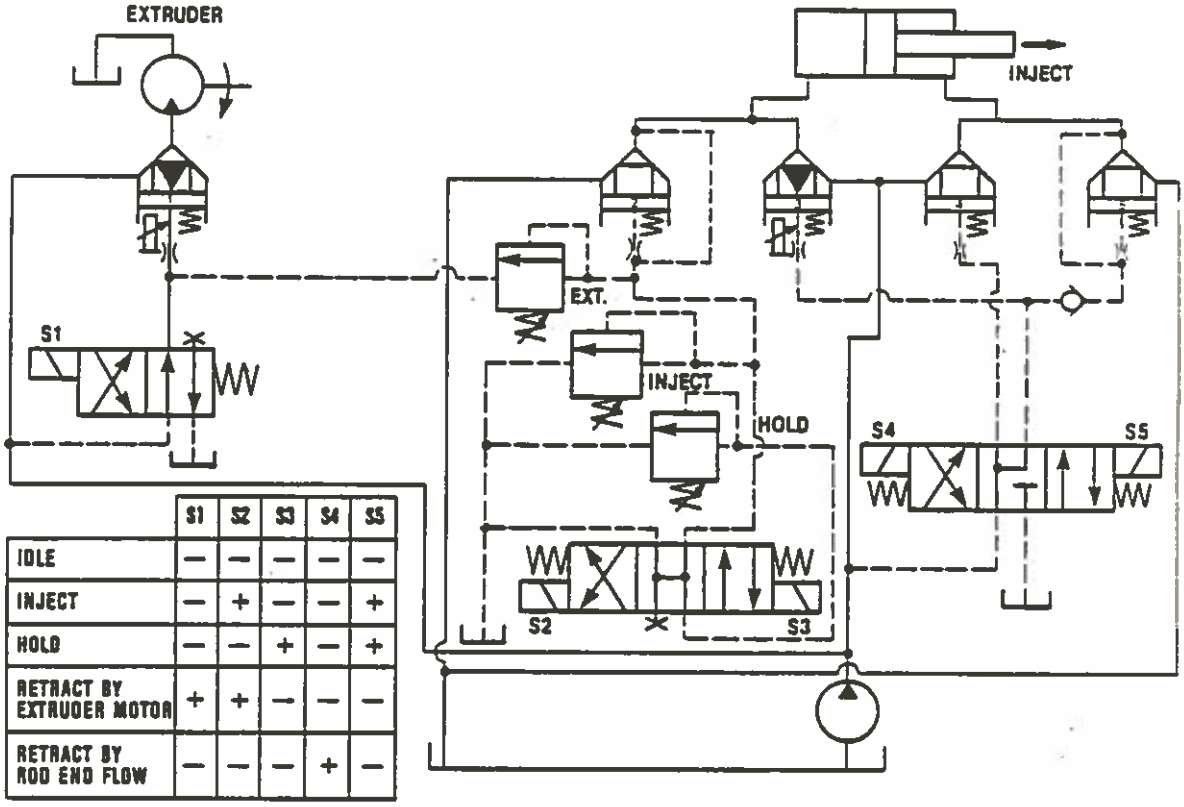
FIGURE NO. 52 (cont'd)

The main stage poppet is opened by the discharge flow from the motor. When the motor is up to full speed the inlet pressure of the motor will decrease. However, it is still high enough to keep the pilot valve shifted and the metering poppet spring chamber drained to tank. The motor then will be driven at the speed determined by the pump delivery.

When the solenoid is de-energized to stop the motor, the cartridge valve is piloted closed by the pump pressure in its spring chamber. The pressure at the motor inlet will drop to Ø bar, allowing the pilot spool to move toward its spring offset position. The inertia of the motor load now drives the motor as though it were a pump, causing pressure at its outlet to increase. The pressure increase at the spring chamber of the metering poppet is limited by the relief valve cover which in turn will determine the motor outlet pressure. This pressure at the motor discharge port will apply a braking force to the motor. The deceleration rate (braking time) can be adjusted at the pilot valve. A check valve should be located between the motor inlet and the tank to prevent the motor from cavitating while decelerating.

50

FIGURE NO. 53



	S1	S2	S3	S4	S5
IDLE	–	–	–	–	–
INJECT	–	+	–	–	+
HOLD	–	–	+	–	+
RETRACT BY EXTRUDER MOTOR	+	+	–	–	–
RETRACT BY ROD END FLOW	–	–	–	+	–

A typical injection and extruder control system can be constructed by applying the basic circuitry that already has been discussed and by adding a few modifications. To control the flow of oil to the extruder motor an additional cartridge is added to the four needed to operate the injection cylinder. Pilot lines are added to cartridge valve 2 so that injection hold and extruder pressures may be attained without adding a large valve.

IDLE

During idle all solenoids are de-energized and pump flow returns to

FIGURE NO. 53 (cont'd)

tank by venting the system relief valve (not shown). Cartridge 2 is allowed to open in case the injection cylinder needs to be mechanically retracted. This is done by venting the spring chamber thru the open center solenoid valve. Cartridges 3, 4 and 5 are held closed by the pump pressure which is being communicated thru the center of the type 7 solenoid valve. The extruder motor remains at rest because there is the same pressure in the B port and the spring chamber of cartridge valve number 1

INJECTION

Solenoid S2 is energized thereby directing pilot pressure from the cap end of the injection cylinder around cartridge 2 to the injection pilot relief valve. This establishes the maximum pressure during injection. Solenoid 5 is energized opening cartridge valves 3 and 5. Cartridge valve number 4 remains closed with system pressure directed to its spring chamber. Injection cylinder speed is controlled by the stroke adjustment cover and 1:2 throttling insert.

HOLD

After injection, a holding force is required of the cylinder. Solenoid S2 is de-energized and S3 is energized. This provides pilot pressure to the "hold" pilot pressure relief valve which limits the cylinder pressure during the hold period.

51

FIGURE NO. 53 (cont'd)

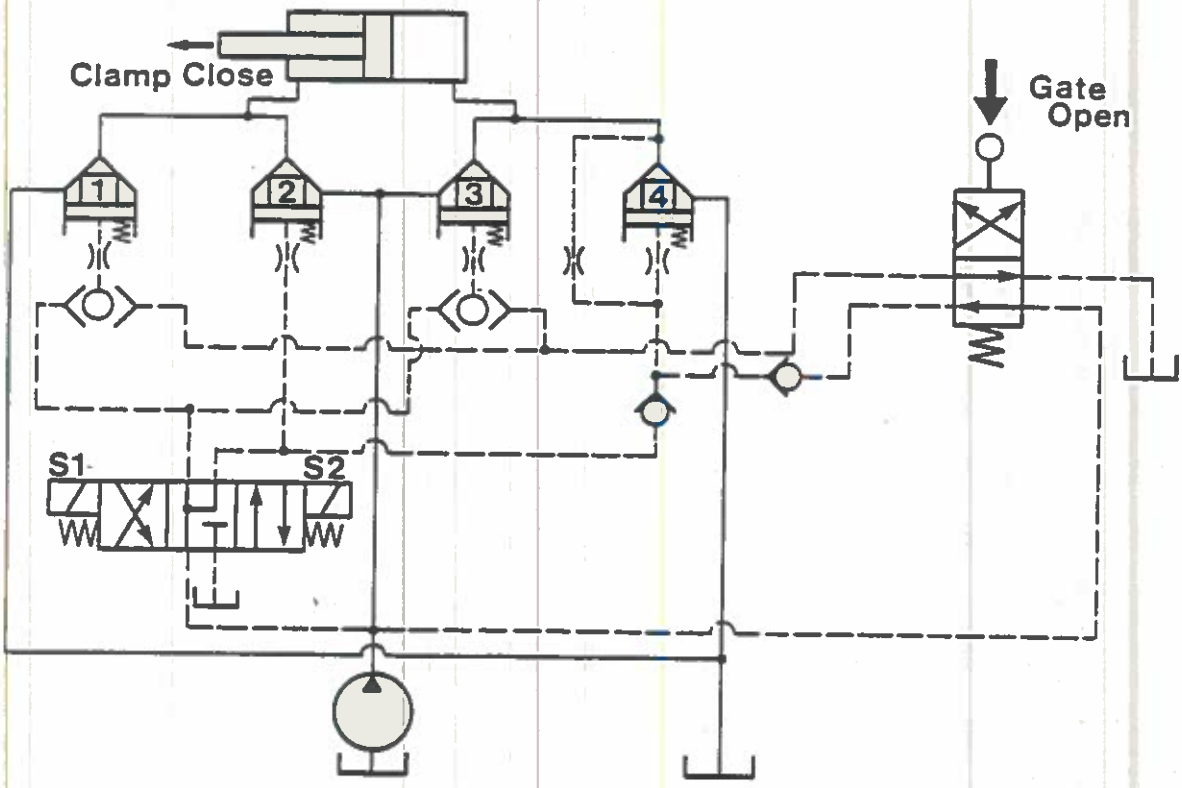
RETRACT BY EXTRUDER MOTOR

After the "Hold" phase, solenoid S3 is de-energized and S2 energized, directing cylinder cap-end pressure to the extruder pilot pressure valve. S5 is de-energized closing cartridges 3 and 4. The check valve in the pilot line of cartridge valve 5 is closed by system pressure. Solenoid S1 is energized thereby directing pump flow to the extruder motor. The flow rate is limited by the stroke adjustment cover setting.. Energizing S1 also allowed the drain line of the extruder pilot relief valve to be connected to tank. While the extruder motor runs, the plastic forces the cylinder to retract. The cap-end flow must pass thru cartridge valve 2 at the pressure setting of the extruder pilot pressure valve. As the rod end pressure drops below atmospheric pressure, the spring chamber pressure in valve 5 also decreases. The B port pressure is atmospheric causing the valve to open and oil to flow into the rod end.

RETRACT BY ROD END FLOW

This operation is required for set up and troubleshooting. By energizing S4, cartridges 1, 3 and 5 are closed, and 2 and 4 are open. The cylinder retracts hydraulically.

FIGURE NO. 54

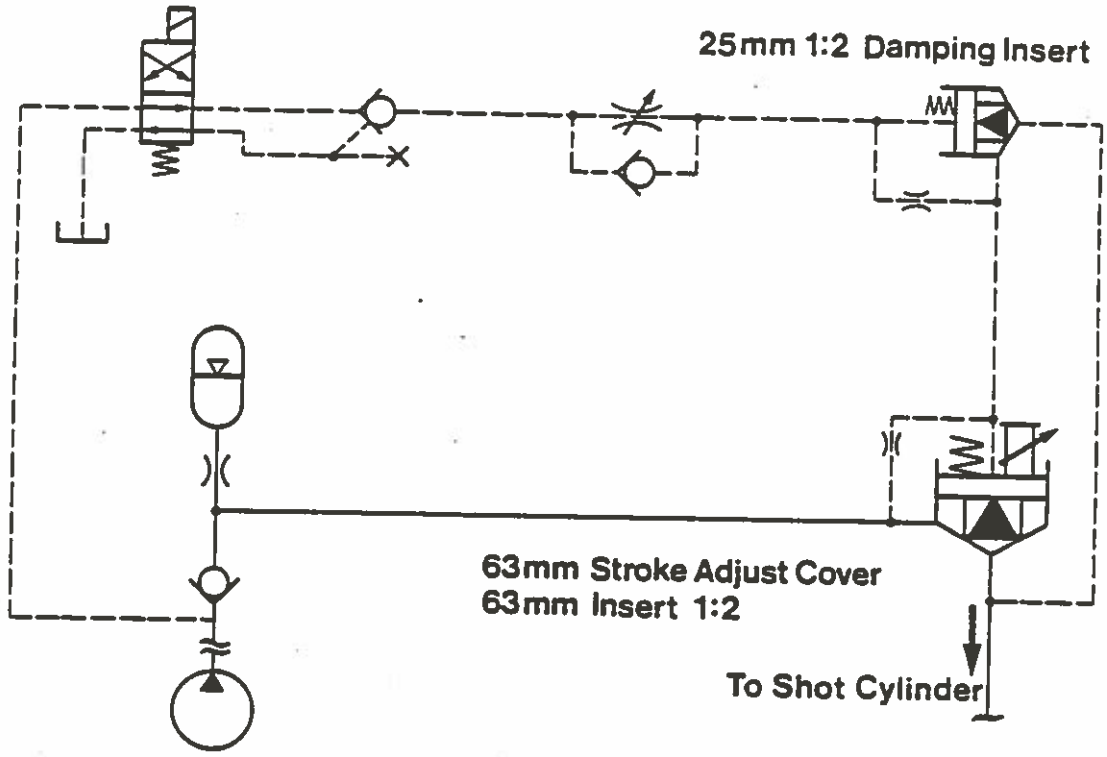


Many injection molding machines incorporate a hydraulic interlock system to prevent the clamp from cloosing as long as the gate is open. This circuit shows that such an interlock can be built by adding two shuttle valves, two check valves and a gate-operated directional valve to a standard cartridge valve circuit.

As drawn, the gate is closed and the clamp cylinder can be operated in either direction and stopped. However, opening the gate drains the AP area of valve 4, allowing it to open if a pressure above the spring force is present at the cap end of the cylinder. Also, if S1 were energized flow from the pump would not be able to open valve #3 because oil at the same pressure would be in its AP area through the shuttle valve and the gate valve. Energizing S2 will direct pump flow into the rod end of the clamp cylinder and allow oil to leave the cap end, thereby opening the clamp.

52

FIGURE NO. 55



This figure show part of the hydraulic circuit for the shot cylinder of a die casting machine. In die casting machines it is very important that the shot is made at consistantly high speeds. One way to meet this requirement is to use an accumulator in combination with a cartridge valve which can be opened quickly but always at the same speed.

The required large flow rates are supplied by the accumulator circuit. The rate of flow is controlled by a 63mm, 1:2 insert with stroke adjustment cover. An opening rate of 10 milliseconds requires an instantaneous flow rate of approximately 60 GPM out of the AP area. To handle such a large flow requires a 25mm, 1:2 damping insert, cartridge valve as the pilot valve.

FIGURE NO. 55 (cont'd)

Orifices in both cartridge valve covers, plus a meter-out circuit in the 25mm pilot line provide control of the opening and closing times of the main 63mm poppet. The pilot operated check valve is opened by energizing the solenoid on the spring offset two-position directional control valve. This directs oil from the pump, not the accumulator, to open the pilot operated check valve and thus the pump must be operating to open the main cartridge and start the shot cylinder movement.

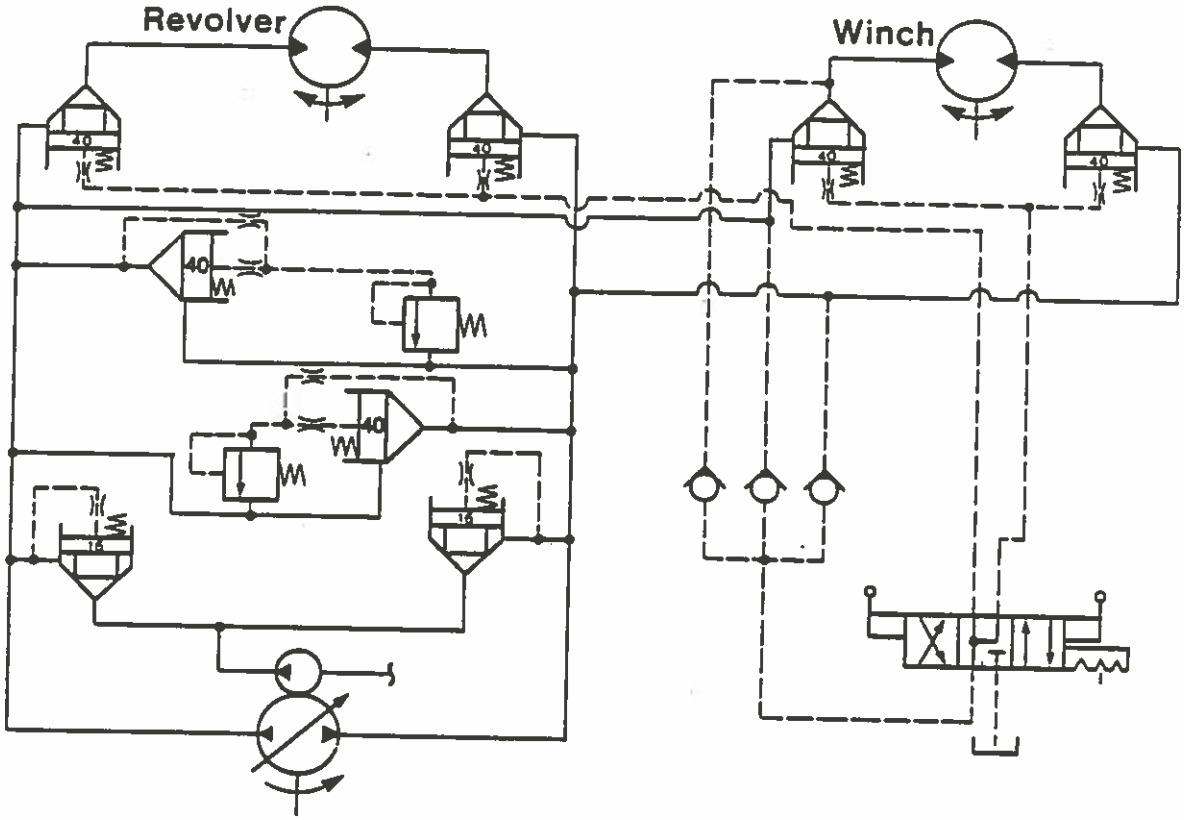


FIGURE NO. 56

This agricultural combine hydraulic system includes two closed loop circuits. The left side of the circuit operates the traction motors and the right side of the circuit drives the header.

A special feature of this circuit is that the output of the header drive pump can be added to the traction system to provide higher speeds for over-the-road operation.

FIGURE NO. 56 (cont'd)

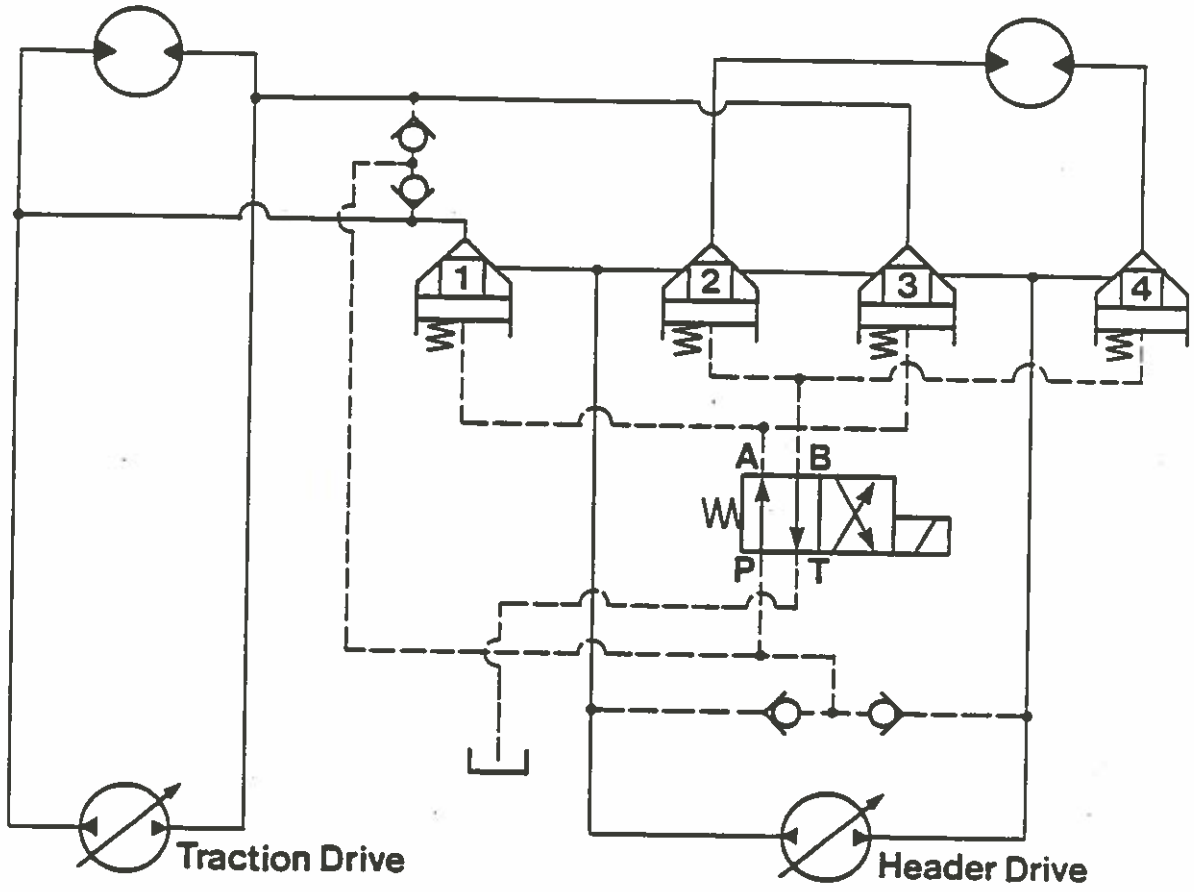
During the harvesting operations the directional valve is de-energized, allowing each system to operate independently.. When higher speed, over-the-road travel is required, the solenoid is energized, shjifting the spool to close cartridge valves 2 and 4 and open valve 1 and 3. The four check valves ensure that the highest system pressure is always available to keep the proper cartridge valves closed. The speed and direction of operation of the traction drive is controlled by the yoke positions of the two pumps.

In addition to the components shown in this circuit, it is necessary to have charge pumps and their associated relief and replenishing valves.

CAUTION: If the solenoid valve is shifted while either the traction motor or the header motor is operating, high hydraulic shock loads may occur.

54

FIGURE NO. 57



Here is a hydrostatic transmission system in which one pump drives two independent motors. It is part of a hydraulic system on an oilfield exploration vehicle. The Revolver turns the drill and the Winch raises and lowers the drill and casing in the ground. The two motors never operate at the same time so only one pump with appropriate control valve is necessary to power the two motors. The two 16mm valves direct supercharge oil to the low pressure branch of the loop. Main system relief is provided by the two 40mm, 1:1 cartridge valves. The three check valves sample both brranches of the loop as well as the "raise" side of the winch motor. This arrangement ensures that control pressure is available whenever it is necessary, whether or not the pump is running.

FIGURE NO. 58

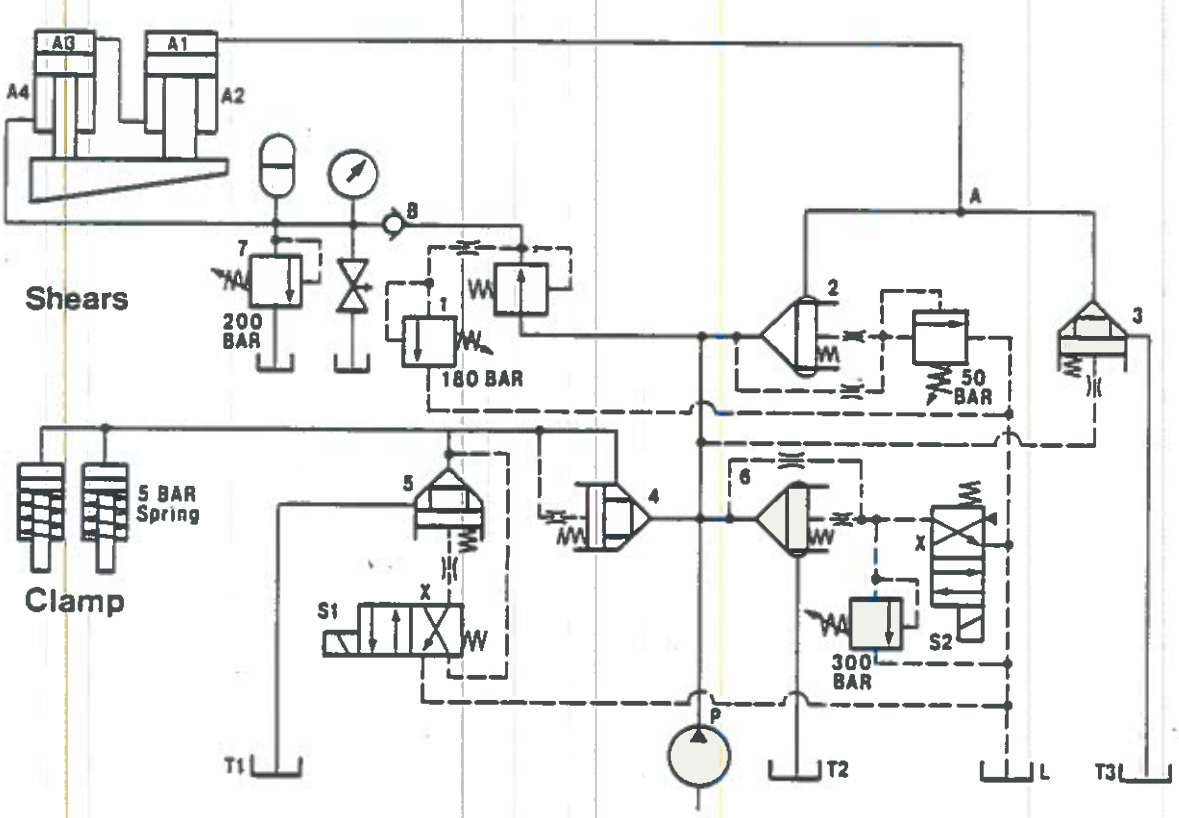


Plate shears

SOLENOID CHART

		S1	S2
CYCLE:	1. Clamp cylinder extension	x	x
	2. Shear cylinder extension	x	x
	3. Shear cylinder retraction	o	o
	4. Clamp cylinder retraction	o	o

VALVE	FUNCTION	SETTING
1	Pressure reducing	180 bar
2	Sequence	50 bar
3	Check (remote pilot)	--
4	Check	--
5	Check	--
6	Relief	300 bar
7	Relief	200 bar

Operation 1 - Clamp Extension

Solenoids S1 and S2 are energized. Solenoid valve S2 shifts to block the pilot chamber of cartridge 6 producing the relief valve

55

FIGURE NO. 58 (cont'd)

function of the cartridge. The shifting of solenoid S1 connects the AP area to the A port of cartridge 5, creating a check valve function.

The pressure in line P builds to the pressure required to overcome the spring of cartridge 4. Cartridge 4 opens allowing pump flow to be ported to the clamping cylinders at a pressure of 5 bar. Valve 2 remains closed because pressure at its A port has not reached its cover setting of 50 bar. The pressure in line P also acts on area AP of valve 3 as well as on area A4 of the shear cylinder. The area ratio between A1 and A4 on the two cylinders is 1:4. (Each cylinder has a 2:1 area ratio). Therefore, the pressure at point A is 1/4 of the pressure at area AP of cartridge 3. Thus, valve 3 is closed. The clamp cylinders extend without shear cylinder motion.

Operation 2 - Shear Cylinder Extension

After the clamping cylinders have engaged the plate, the pressure in line P will increase to 50 bar at which time the sequence valve, cartridge number 2, will open. Flow is directed to the cylinder through cartridge 2, causing the cylinder to extend. The accumulator at the cylinder outlet is sized to hold the entire displacement of shear cylinder area A4 at a pressure of 150 to 180 bar.

The cylinder extends fully, engaging and cutting the plate. The pressure rised to the relief valve setting of 300 bar.

FIGURE NO. 58 (cont'd)

In case the fluid leaving the shear cylinder is unable to raise the accumulator pressure to 180 bar, fluid from the pump is available. Valve number 1, the pressure reducing valve, limits the accumulator pressure to 180 bar. This arrangement insures the accumulator is filled for the return function.

Operation 3 - Cylinder Return

Solenoid 2 is de-energized unloading relief valve 6. The pump pressure drops to approximately 4 bar. With pressure at its A port down to 4 bar, the poppet spring in valve 2 is able to reseat the poppet.

The accumulator exerts a pressure of 180 bar on area A4 of the shear cylinder. This pressure equates to 45 bar on area A1 of the cylinder. However, cartridge 3 has only 4 bar on area AP and therefore only requires 8 bar plus the pressure needed to overcome the spring to open. Cartridge 3 opens allowing the volume from A1 of the cyulinder to be ported to tank.

Operation 4 - Clamp Release

When the shear cylinder reaches the end of the cutting stroke the pump pressure rises to 300 bar. This pressure is also transmitted to the clamping cylinders through cartridge 4.

56

FIGURE NO 58 (cont'd)

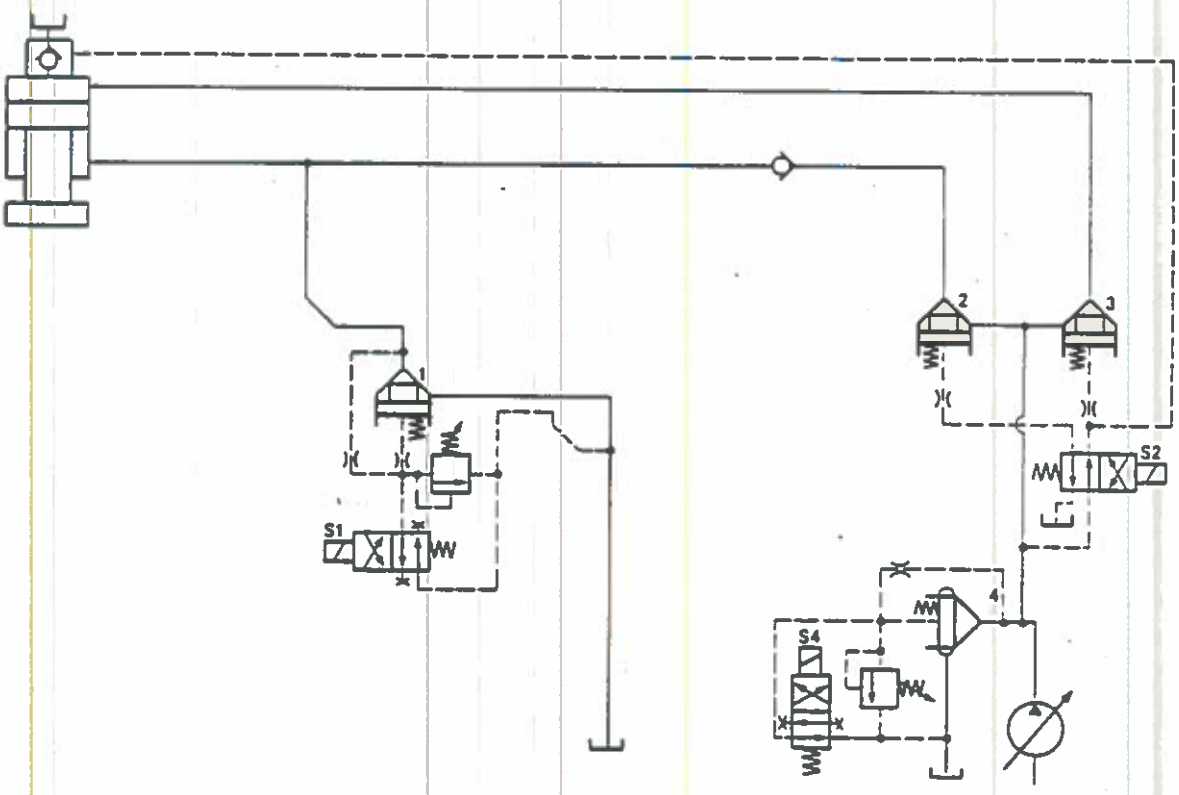
With equal pressures on each side of cartridge 4 the spring forces the valve closed. When the pump unloads, cartridge 5 remains closed because the same pressure is acting on unequal area, the larger being the AP area.

To allow retraction of the clamp cylinder solenoid S1 is de-energized. Area AP of valve 5 is connected to tank allowing oil from the cylinder to be ported to tank at a pressure adequate to overcome the cartridge spring force.

It looks as though the clamp could be released simply by allowing its oil to drain to tank via the system relief valve, which is vented at this time. Won't work very well! The springs in the clamp can develop a pressure of only 5 bar. Thats not much pressure to shove oil through the vented relief valve, especially since it is already handling all the oil coming from the pump.

Valve 7, which is set at 200 bar, limits pressure in the accumulator circuit. The needle valve allows bleed down of the accumulator.

FIGURE NO. 59



PRESS - Figure 1

A simple press circuit is shown in figure 59, Drawing 1. The cylinder has an 8:1 aeration and contains a prefill valve on its cap end.

A variable displacement pump is used to supply oil to the cylinder.

Valve number 4 is a relief valve (area ratio 1:1) set at 300 bar. When solenoid S4 is de-energized the relief valve vents at approximately 4 bar.

57

FIGURE NO. 59 (cont'd)

Valve (1) is a back pressure valve which provides a resistance of 25 bar as long as solenoid S1 is de-energized. This pressure is sufficient to prevent the piston from falling when no pressure is applied to the head end of the cylinder. When solenoid S1 is energized the rod end is connected to tank at a low pressure; just sufficient to overcome the poppet spring in the cartridge valve.

PRESS OPERATION

SOLENOID OPERATION

		S1	S2	S4
1.	Free Fall	+	o	o
2.	Decelerate and Slow advance	Ø	+	+
3.	Press at maximum force	+	+	+
4.	Return	o	o	+

Operation 1 - Free Fall

The pump is unloaded through cartridge 4. Solenoid S1 is energized connecting the rod end of the cylinder to tank, allowing the mass to fall. The prefill valve opens supplying oil to the cap end of the cylinder during descent.

Operation 2 - Deceleration and Slow Extension

Solenoid S1 is de-energized creating a back pressure of 25 bar on the cylinder. This is sufficient to stop the piston. Note the time required to stop the mass is inversely proportional to the valve setting.

FIGURE NO. 59 (cont'd)

Solenoid S2 is energized opening cartridge 3 and closing cartridge 2.

Solenoid S4 is energized changing cartridge 4 from an unloading to a relief function, in other words, de-venting the relief valve.

Oil is pumped to the cap end of the cylinder causing the piston to extend.

Solenoid S1 remains de-energized directing oil from the rod end to tank at 25 bar.

Operation 3 - Press

When the piston engages the part being formed, the pump pressure builds to the relief valve setting of 300 bar.

Solenoid S1 is energized to relieve the back pressure on the piston thereby allowing maximum press force.

Operation 4 - Return

Solenoid S4 remains energized to keep the relief valve de-vented.

Solenoid S1 is de-energized to create a back pressure on the rod end of the cylinder.

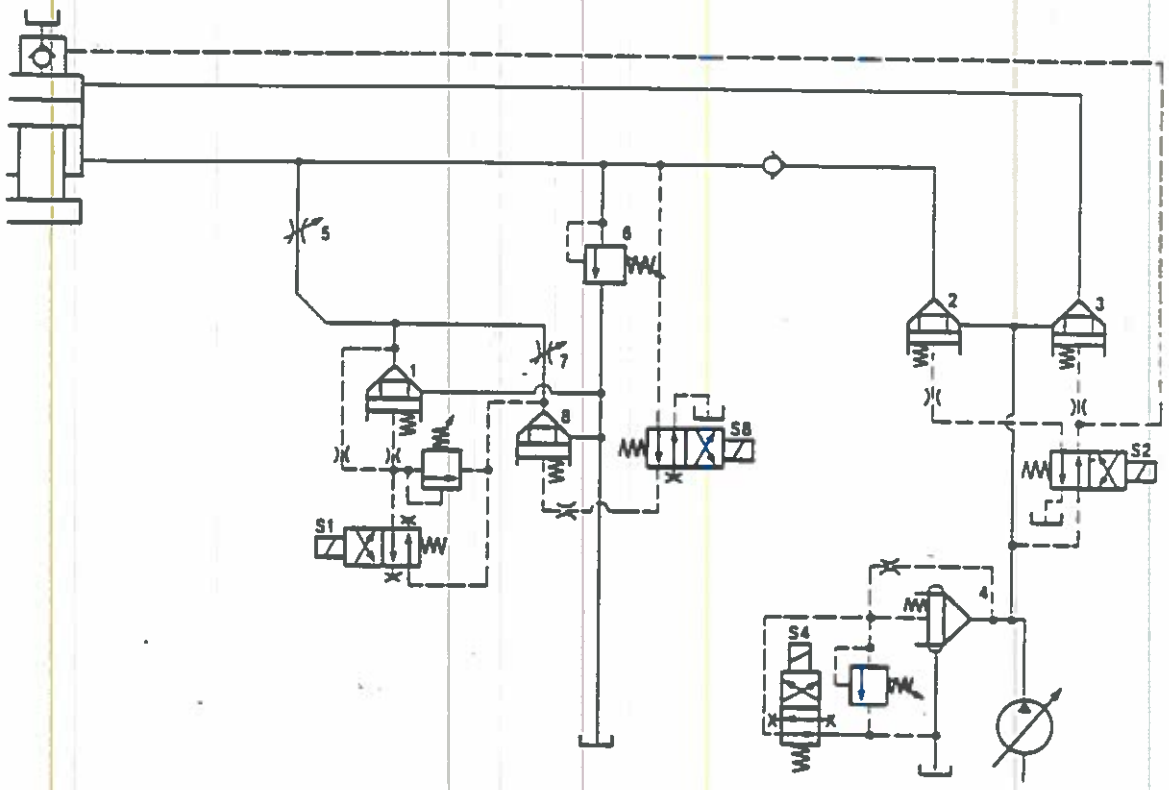
58

FIGURE NO. 59 (cont'd)

Solenoid S2 is de-energized causing valve 3 to close and valve 2 to open.

Oil is ported over valve 2 at a pressure sufficient to raise the mass (less than 25 bar in this press).

When the pilot area of cartridge 3 is pressurized the pilot area of the prefill check valve is also pressurized allowing oil to return to the tank from the cap end of the cylinder.



PRESS-Figure 2

Improved control of the piston descent operation is obtained by adding several valves to the circuit.

Added Valves	Function
5	Throttle for fast descent
6	Limits maximum pressure in rod end of cylinder to 320 bar.
7	Throttle for slow descent.
8	Directional control.

Operations (descent only)

	SOLENOID OPERATION	
	S1	S2
1. Fast descent	+	+
2. Slow descent	o	+
3. Stop	o	o

59

FIGURE NO. 60 (cont'd)

Operation 1 - Fast Descent

Both solenoids (S1 and S8) are energized allowing cartridges 1 and 8 to open.

Return flow from the cylinder passes through throttle 5.

Flow from the throttle passes through cartridge 1. Some oil may also pass through throttle 7 and over cartridge 8, each of which is piped in parallel to cartridge 1.

Operation 2 - Slow Descent

Solenoid S1 is de-energized allowing flow to pass over cartridge 1, only at pressures greater than 25 bar.

After a short deceleration the piston speed stabilizes. Flow passes through throttles 5 and 7 and over cartridge 8. Cartridge 8 is open to tank because solenoid 8 is energized,

Operation 3 - Stop

To stop the piston, solenoid S8 is de-energized. This closes cartridge 8. Cartridge 8 blocks the return flow from the cylinder and also blocks the pilot relief drain connection from cartridge 1.

FIGURE NO. 60 (cont'd)

With no place for the fluid to go, the piston stops. Although relief valve 5 is set at 320 bar, the weight of the piston and platen creates only 25 bar.

60

Valve number 9 provides an additional means of stopping the downward moving platten.

When solenoid S9 is de-energized, cartridge 9 acts as a check valve blocking all return flow from the cylinder.

When solenoid S9 is energized, valve 9 opens, allowing the function described in drawings 1 and 2.

Note that electrical position sensors have been added to valves 1, 8, and 9. They can be connected to indicators at the operators control station to provide information on whether these valvesw are open or dclosed or somewhere in between.

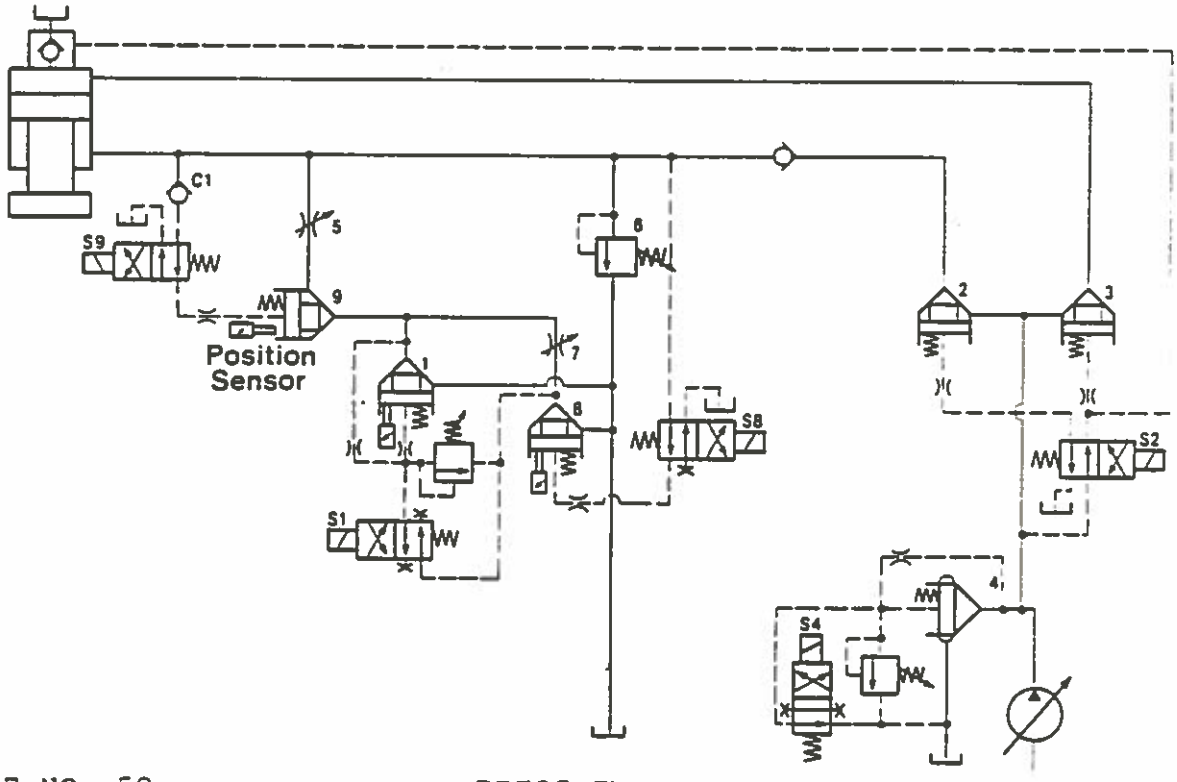
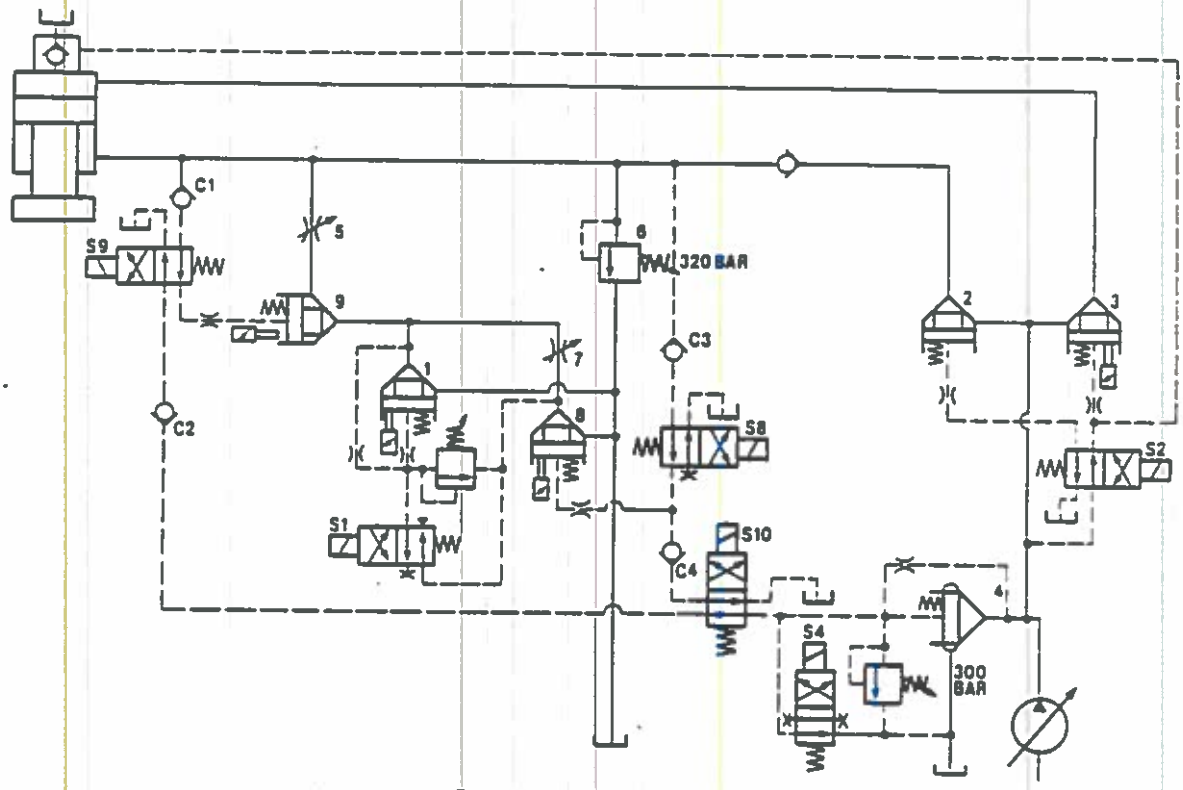


FIGURE NO. 59

PRESS-Figure 3

FIGURE NO. 62



PRESS-Figure 4

Up to this point valving has been added to the outlet of the rod end of the cylinder to establish smoother operation of the press.

When fluid is supplied to the cap end of the cylinder the piston will move downward and the oil from the rod end will be forced over relief valve 6 which is set at 320 bar. Since the cylinder area ratio is 8:1 and the main relief valve is set at 300 bar, only 38 bar would be required on the cap end.

To alleviate this highly undesirable possibility, solenoid valve S10 is added. Three check valves are also added to complete the circuit.

61

FIGURE NO. 62 (cont'd)

Press or Slow Extension:

During normal operation solenoid valve S1Ø functions as follows:

Retraction:

Solenoid S1Ø is energized porting oil to valve S8. Solenoid S8 is de-energized during this phase. Flow from the relief pilot is blocked by check valve C3 and area AP of cartridge valve 8. The relief valve 4 is not unloaded. Solenoid S1Ø is de-energized. Flow is ported to solenoid valve S9. During this phase, solenoid S9 is energized blocking the pilot flow from the relief valve at check valve C1.

If a malfunction in either the "Press" or "Slow Extension" phase is detected by the position sensors on valves 1, 8, or 9, solenoid S9 will de-energize, thereby venting the relief valve. This limits the pressure in the cap end of the cylinder to 2 bar. Therefore the piston stops its travel.

CARTRIDGE VALVE TRAINING PROGRAM

INTRODUCTION

Cartridge valves are now being applied on shears, heavy presses, agricultural machinery, injection molding machines, cranes. etc., because they provide improved hydraulic system performance at competitive cost.

The use of cartridge vavles as flow, pressure, and directional controls is a recent and rapidly growing phenomenon. Cartridge valves offer a number of advantages over the traditional sliding spool types of control valves:

- low internal leakage means improved control and higher system efficiency.
- fast response allows higher production rates.
- less plumbing cuts maintenance costs.
- high flow and pressure capability reduces system size.
- easy control of poppet shift velocity eliminates hydraulic shock.

The objective of this cartridge valve training program text is to enable experienced hydraulic sales and service personal to understand how cartridge valves operate in hydraulic systems.

VICKERS INC.

TECHNICAL TRAINING CENTER

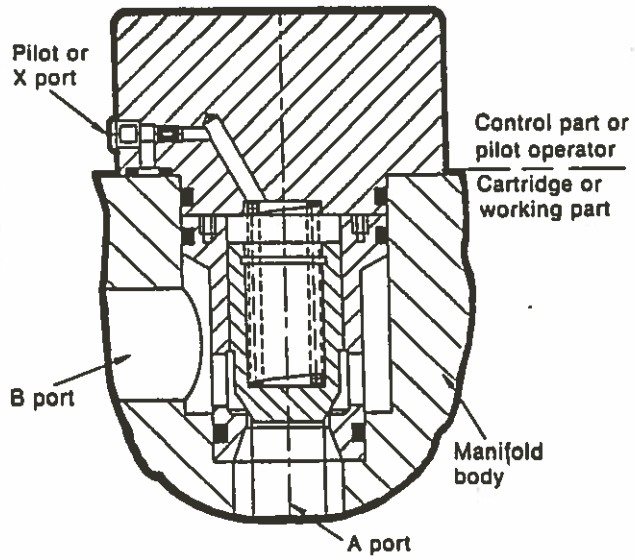
PREPARED BY...FRED HINES

Rev. 10/25/85

INDEX

	PAGE
Introduction	1
Index	2
Basic operation	3-24
Area ratios	5-15
Flow Charactereristics	15-17
Basic Circuit	20-24
Covers	25-38
Stroke Adjust	25
Directional Valve Interface	26 & 27
Valve response	28
Shuttle Cover	29-31
Shuttle With Directional Interface	32
Pilot Operated Check Cover	33-36
Basic Circuits	37 & 38
Relief valve operation	39-46
Reducing Valve Operation	47-50
Pressure Compensated Flow Controls	51-62
Bypass Type	51-57
Restrictor Type	58-62
Electro-Hydraulic Portportional Valves	63-66
Pressure Control Circuits	67-76
Unloading	68 & 69
Sequence	70 & 71
Counterbalance	72-74
Brake Circuit	75 & 76

BASIC CARTRIDGE VALVE



FIGUIRE NO 1

A cartridge valve is a two-port poppet valve kit inserted in a manifold. A typical valve consists of a sleeve, poppet and spring inserted into a manifold. The poppet moves within the sleeve to control flow through the valve. The insert parts are held in the manifold by a cover which contains a pilot flow passage. O rings and backup rings seal the cover and insert at the manifold bore.

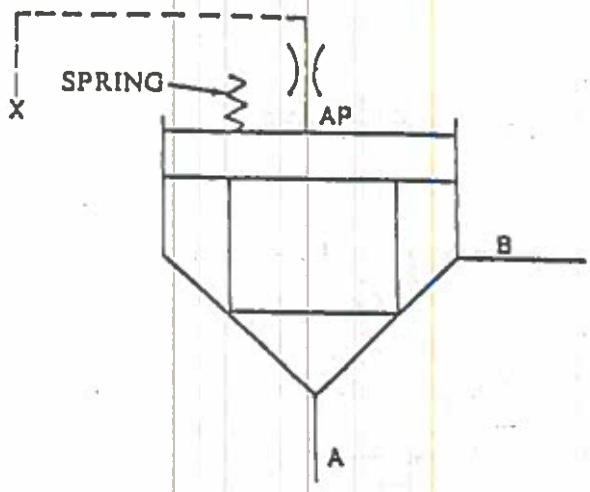
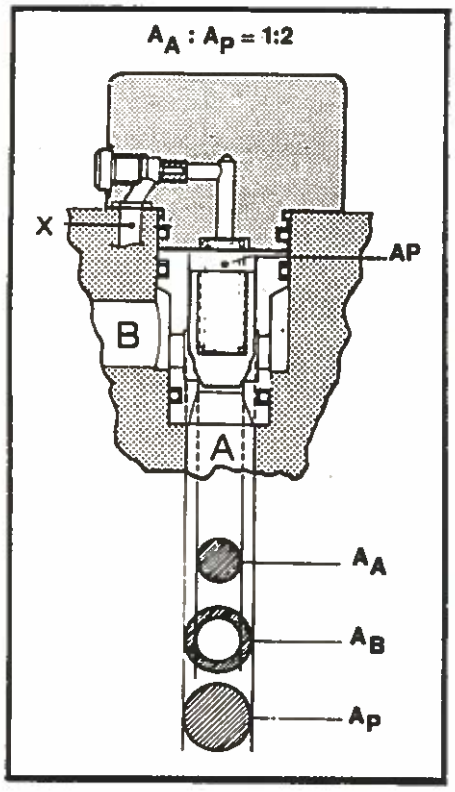
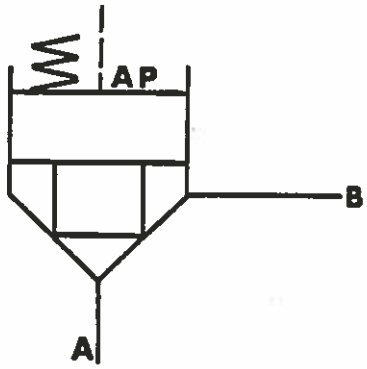


FIGURE NO 2

A cartridge valve graphical symbol depicts the areas of the poppet which are active at each port. Pressure applied to either of the main ports exerts a force on the poppet to move it off its seat, allowing flow throught the valve. If pressure is applied to the AP area, a force is exerted to help the spring close the valve.

The most common area ratio is 1:2. The areas being compared in this ratio are the pressure area of the A port to the AP area.





FORCE = PRESSURE × AREA

Force To Close

Pilot Pressure × AP Area		Lbs.
Spring Force		Lbs.
Sum of Closing Forces		Lbs.

Force to Open

"A" Port Pressure × Area		Lbs.
"B" Port Pressure × Area		Lbs.
Sum of Opening Forces		Lbs.

FIGURE NO 3

The insert kit may be thought of as the main stage of a two-stage valve. it has two main flow ports, A and B. It is spring off-set so that A and B are both normally closed. The poppet has an area labeled AP (area of pilot), against which pilot pressure can act.

The A port area is the circular area defined by the seat. The AP area is the circular area defined by the outside diameter of the poppet.

FIGURE NO. 3 (cont'd)

The B area is the annular area between the seat and the O.D. of the poppet. Note that the AP area is always equal to the sum of the A area and the B area.

The forces which hold the valve closed are the pressure acting on the AP area plus the spring force. The opening forces are the pressures in the A and B ports.
Three different springs are available with each insert kit. For the 1:2 insert, the springs cause poppet cracking pressures of either Ø.5, 2.5 or 5.Ø bar. (In english units thats approximately 7, 37, or 74 psi because 1 bar = 14.5 psi.).

For example, when the medium spring is used and there is no pressure in B or on AP, it will take 2.5 bar in the A port before any flow will pass from A to B. Since the area ratio is 1:2 and the area of A plus the area of B equals the AP area, the B area is equal to the A area. The cracking pressure when flow is from B to A will be the same as when the flow is from A to B.

If the sum of the closing forces is greater than the sum of the opening forces the poppet is closed. If the sum of the opening forces is greater than the sum of the closing forces the poppet is open.

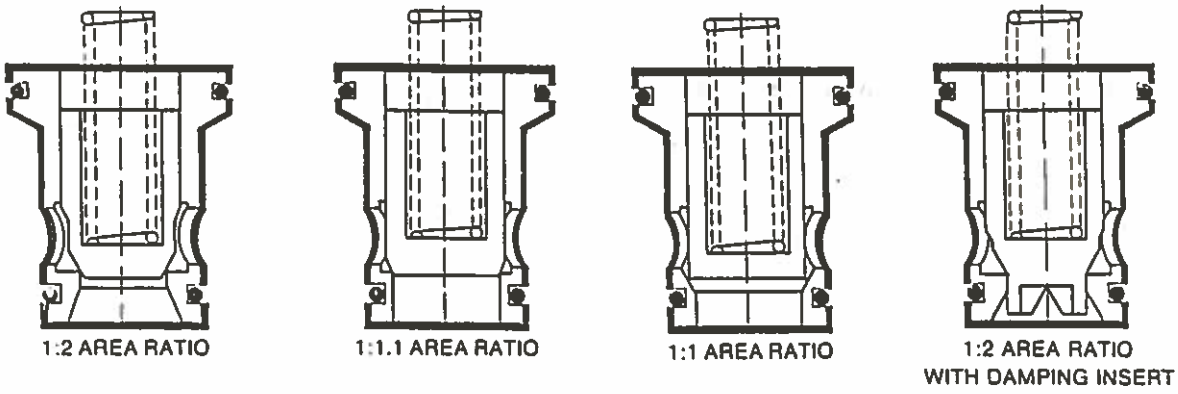


FIGURE NO. 4

Figure 4 shows the construction of various types of insert kits. Three different area ratios are shown. Note that both the nose of the poppet and the sleeve seat change configuration with each different area ratio. The poppet on the left-hand side which has an area ratio of 1:2, has a chamfered nose, and the sleeve has a sharp edged seat. If we move on to the 1:1 area ratio, the poppet itself is square-cornered at the bottom while the sleeve is chamfered where the poppet comes in contact with it. This makes the sleeves non-interchangeable among the poppet area ratios.

Figure No. 4 (cont'd)

The 1:1:1 area ratio has a chamfer on the poppet, but it is a much smaller chamfer than that on the 1:2 area poppet and the seat diameter in the sleeve is larger. This means there is a relatively small area of the poppet on which the pressure in the B port can act. The area amounts to only 10% of the A port area.

To the right is a 1:2 area ratio with a damping poppet. This poppet seat area is the same as the 1:2 standard poppet. However, the nose of the poppet has been extended and a V notch cut in it to provide flow metering. This poppet is generally used in flow control devices as we'll see later. The size of insert assemblies vary from 16mm to 63mm. This covers a flow range of 46 gal./min. to 658 gal/min.

The size designation corresponds to the diameter of the main port passage in the manifold (in mm).

The pressure rating of the inserts and covers is 5000 PSI.

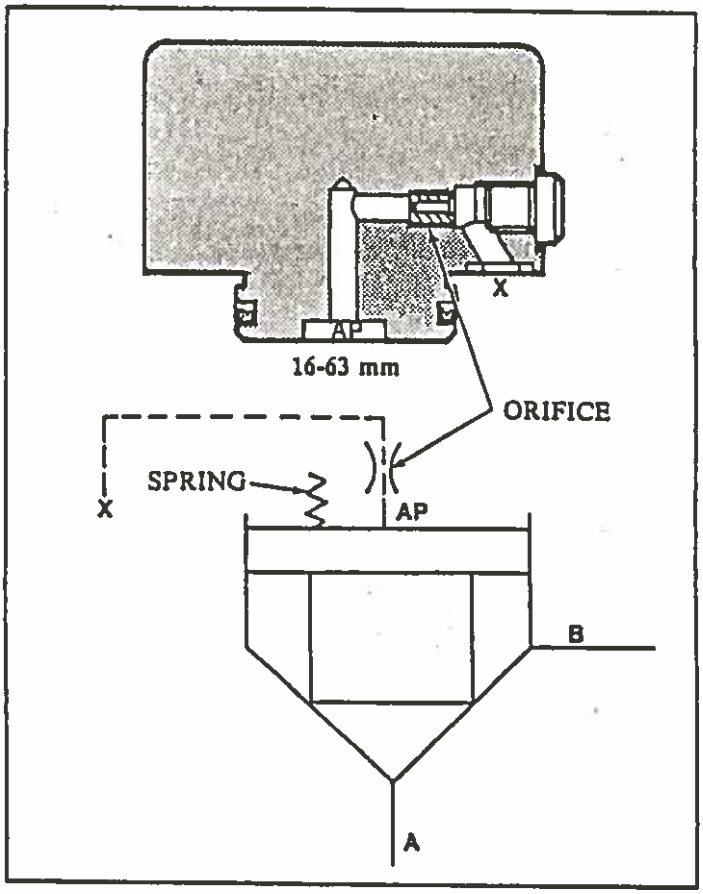


FIGURE NO. 5

Figure 5 shows a sectional view of a standard cover and also shows the symbol for a complete cartridge valve. Note the orifice in the drilled passage between the X port and the AP area. The purpose of this orifice is to reduce the.speed at which the valve opens and closes. A variety of orifice sizes is available so that the hydraulic system designer can select the one which will provide maximum operating speeds without hydraulic shock.

Poppet cracking pressures with pressure applied to 'A' port, 'AP' area drained.			
SPRING TYPE	AREA RATIOS		
	1:1	1:1.1	1:2
Light		0.3 bar	0.5 bar
Medium		1.4 bar	2.5 bar
Heavy	2.5 bar	2.7 bar	5.0 bar

FIGURE NO. 6

To be able to design or troubleshoot a circuit incorporating cartridge valves it is essential that you know the answer to one very important question: How much pressure does it take to move the poppet? Sounds easy? Well, it is.

Just remember the number 3. There are three areas for the pressure to act on; A, B, and AP.
There are three available springs; light, medium, and heavy.
There are three available area rations; 1:1, 1:1.1 and 1:2.

Figure 6 shows how much pressure it takes at the A port to start to open the valve when there is no pressure at both the B.and the AP areas.

Note that no pressures are shown for the light and medium springs in the 1:1 valve. That's because only the heavy spring is supplied with that valve.

Poppet cracking pressures with pressure applied to 'B' port. 'AP' area drained.			
SPRING TYPE	AREA RATIOS		
	1:1	1:1.1	1:2
Light	—	3.4 bar	0.5 bar
Medium	—	17.0 bar	2.5 bar
Heavy	—	34.0 bar	5.0 bar

Figure No. 7

Figure no 7 shows the pressures required at the B port to lift the poppet. That's with no pressure at the A or AP areas. The 1:1 poppet on the chart lists no pressure because the 1:1 poppet has no surface area for pressure at the B port to push against. Therefore, lifting pressure can only come from the A area in the 1:1 valve.

Note that in the 1:2 area valve the cracking pressures at the B port are the same as those at the A port. That's because the A and B areas are equal.

Further note that if you go back to the formula for determining whether the poppet is open or closed, the combined areas of the A and B ports and the pressures at them will equal the sum of the forces on the AP area plus the spring force.

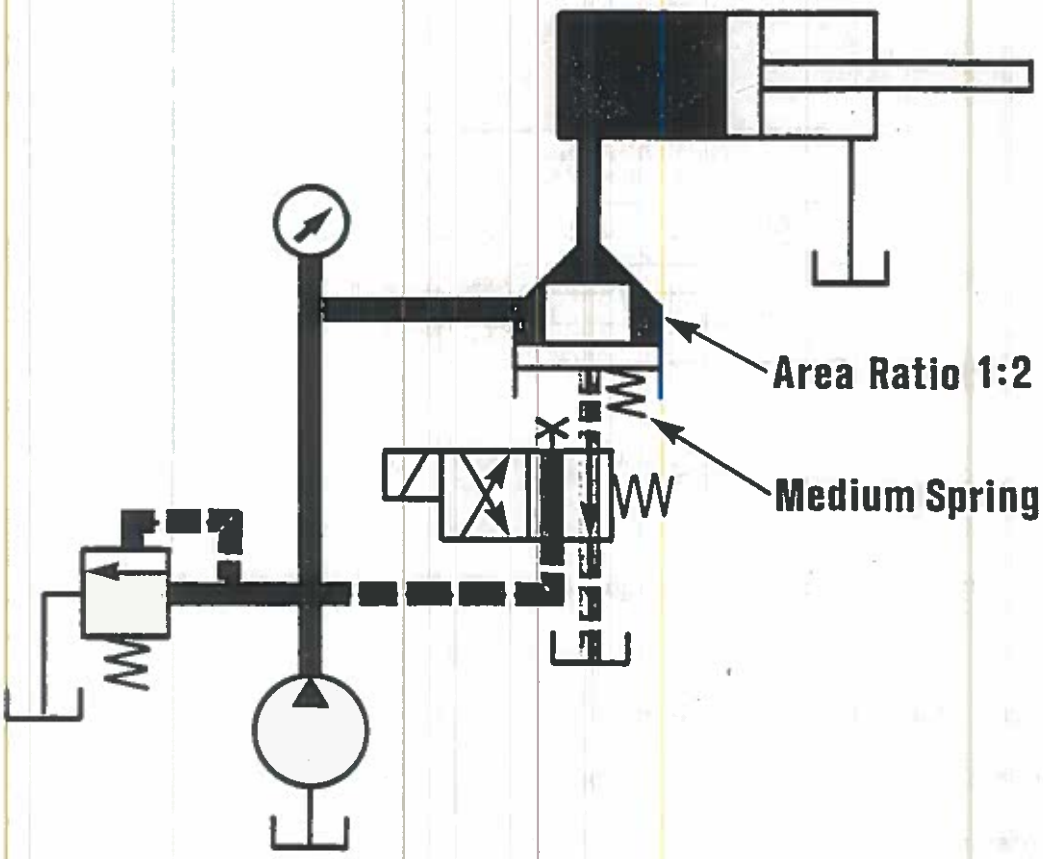


FIGURE NØ. 8

In this circuit we are supplying flow to a cylinder through a cartridge valve which is open because we have drained the spring chamber of the cartridge valve through a directional valve. The only force trying to close the valve is the spring force. If the system pressure is higher than 2.5 bar the valve will open. Assume that it takes 5Ø bar to move the cylinder. This means that there is 5Ø bar on the A area and 5Ø on the B area and zero on the AP area. The valve is wide open.

FIGURE NO. 8 (cont'd)

The calculations are: (Assume AP = 2, A=1, and B = 1)

Closing Force

Spring force				(Medium Spring)		2.5 bar
AP area x pressure	=	2	x	Ø bar	=	Ø bar
						2.5 bar

Opening Force

A area x pressure	=	1	x	5Ø bar	=	5Ø bar
B area x pressure	=	1	x	5Ø bar	=	5Ø bar
						1ØØ bar

Net force is 97.5 bar, There for opening the valve.

If the insert kit has a 1:1.1 area ratio, the calculations of closing and opening forces is as follows:

Closing Force

Spring force				(Medium spring)		1.4 bar
AP area x pressure	=	1.1	x	Ø bar	=	Ø bar
						1.4 bar

Opening Force

A area x pressure	=	1	x	5Ø bar	=	5Ø bar
B area x pressure	=	Ø.1	x	5Ø bar	=	5 bar
						55 bar

Net force is 53.6 bar, There for opening the valve.

Quiz

Given the following parameters, will the valve be open or closed?

a.

Area ratio	1:2
Spring	Light
A port pressure (bar)	50
B " " "	52
X " " "	50

B.

Area ratio	1:1.1
Spring	Light
A port pressure (bar)	50
B " " "	52
X " " "	50

C.

Area ratio	1:2
Spring	Heavy
A port pressure (bar)	4.0
B " " "	4.0
X " " "	0.0

D.

Area ratio	1:1
Spring	Heavy
A port pressure (bar)	1.0
B " " "	20.0
X " " "	00.0

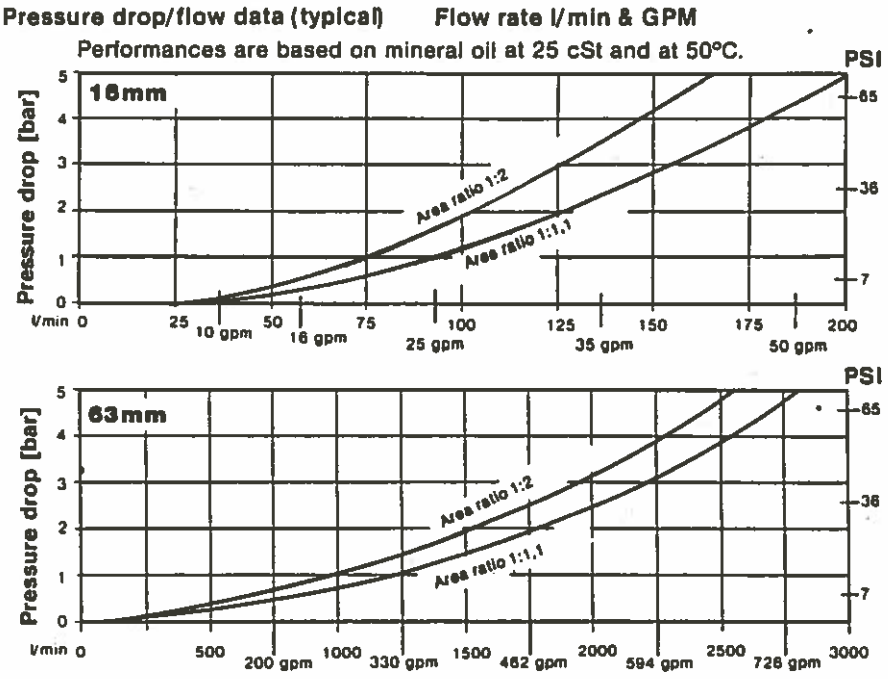

Pressure drop/flow data (typical) Flow rate l/min & GPM
Performances are based on mineral oil at 25 cSt and at 50°C.
16mm
Pressure drop [bar]
Area ratio 1:2
Area ratio 1:1,1
PSI
65
36
7
l/min 0 25 50 75 100 125 150 175 200
10 gpm 16 gpm 25 gpm 35 gpm 50 gpm
63mm
Pressure drop [bar]
Area ratio 1:2
Area ratio 1:1,1
PSI
65
36
7
l/min 0 500 1000 1500 2000 2500 3000
200 gpm 330 gpm 462 gpm 594 gpm 728 gpm

FIGURE NO. 9

These curves show the pressure drop thru the valve with the poppet fully open. There are additional pressure drops within the manifold in which the valve is inserted.

To use these curves to find pressure drops at flows greater than those shown, divide the desired flow in half, read the pressure drop at half flow, multiply the pressure drop by 4 and you have the approximate pressure drop at the desired flow.

For instance, if you want to determine the pressure drop through a 16mm 1:2 valve at 200 lpm, read 1.9 bar at 100 lpm. Then multiply 1.9 times 4 to get 7.6 bar, pressure drop at 200 lpm.

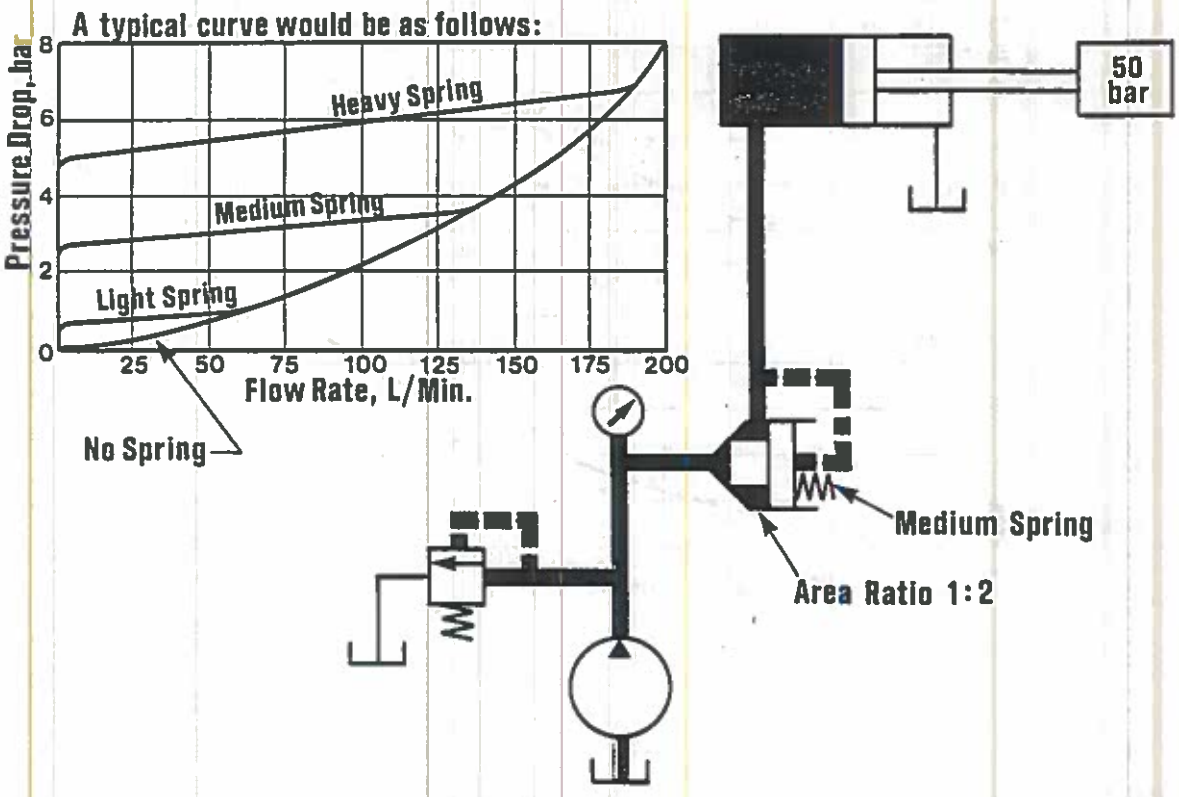


FIGURE NO. 10

When a 1:2 or 1:1.1 cartridge valve is applied as a check valve it is necessary to connect the AP chamber to the B port. If we don't do this then any pressure at the B port greater than 2.5 bar on a 1:2 valve or 17 bar on a 1:1.1 valve will open the valve. As a check valve we want it to open only when there is pressure at the A port. Otherwise it should be closed.

FIGURE NO. 1Ø (cont'd)

There is a slight penalty in connecting the B port to the AP chamber. Pressure at the B port adds to the spring force to resist flow through the valve. Fortunately this penalty is never more than the pressure caused by the spring (2.5 bar in the example shown in figure number 1Ø) and then it disappears entirely when the pressure drop due to flow forces (figure 9) equals or exceeds the spring pressure.

The example in figure number 1Ø shows a load which requires a pressure of 5Ø bar.

The pressure gage shows the load pressure plus the pressure drop through the valve. At 1ØØ liters per minute the curve indicates that ,with the medium spring, the pressure drop will be slightly more than 3 bar. At 15Ø lpm the pressure drop due to flow forces is higher than the spring force and so there is no pressure drop penalty for connecting the B port to the AP chamber.

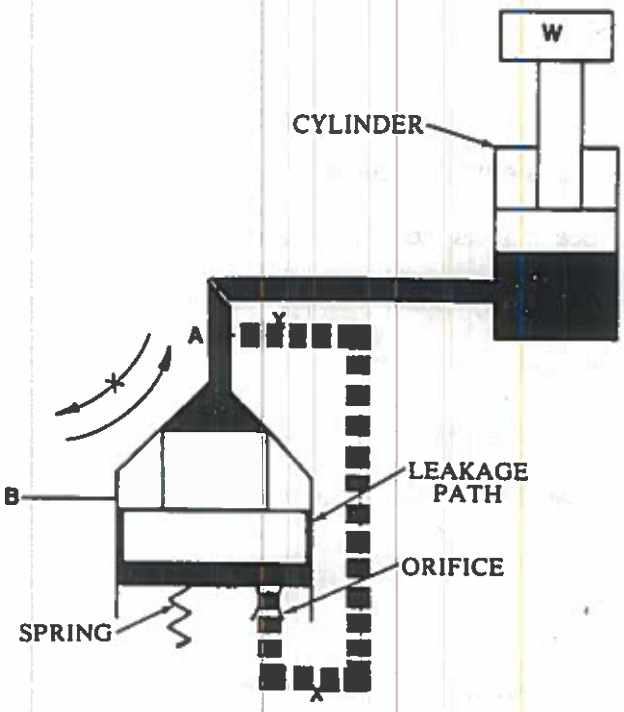


FIGURE NO 11

You might conclude that you could get rid of all pressure loss penalties in check valve installations by connecting the cylinder to the A port instead of the B port. It is not that simple because if you do connect the load to the A port you might well be trading pressure drop for load drop. With the cap end of the cylinder connected to the A port, which in turn is connected to the X port, the cylinder load pressure will probably be high enough to force oil past the radial clearance between the poppet O.D. and the insert I.D. and on through the B port to tank. Although the valve would remain closed the load would, contrary to the system designers wishes, slowly decend.

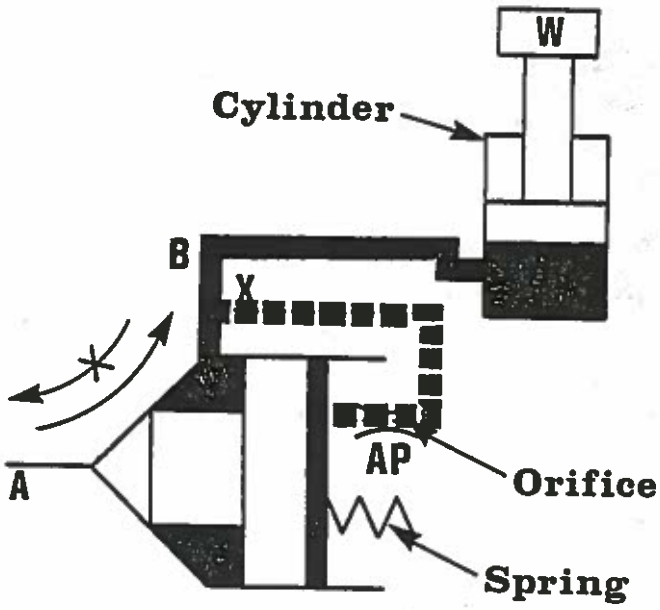


FIGURE NO. 12

This sketch shows the correct port selection for using the cartridge valve as a check valve.

The cartridge has been turned so that the load is being supported on the B area. The X port of the cover has been connected to the B port, allowing the load pressure to be brought into the AP area. At this time the A port will be connected to tank. Fluid from the cap end of the cylinder is blocked by the metal-to-metal seal of the poppet on its seat. Having the same pressure on the B and AP areas, gives equal pressure across the poppet land and therefore no leakage occurs and the load stays in position.

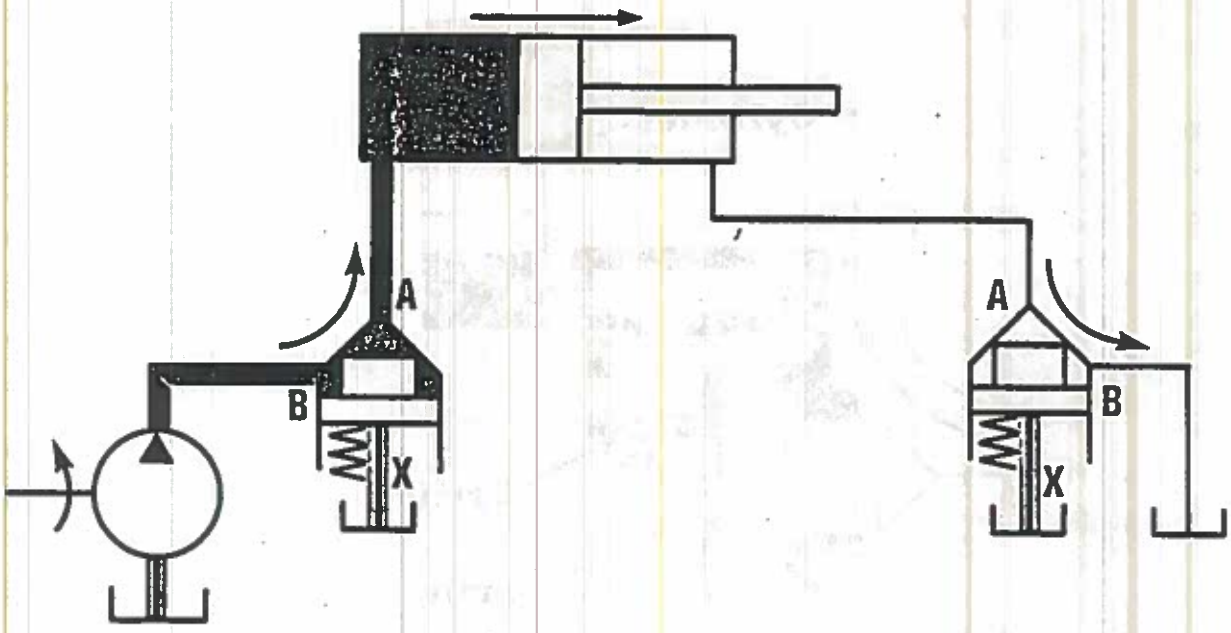


FIGURE NO. 13

Four-way directional control valves, by definition, provide four flow paths, two at a time. One application of a four-way valve is to extend, retract, and stop the piston of a double acting cylinder. Figure 13, 14, and 15 show how cartridge valves can be installed to operate together as a single four-way valve.

Figure 13 shows a circuit in which the piston will extend when the AP areas of both inserts are connected to tank.

Connecting supply pressure to the X port of the cap-end cartridge valve will stop the piston.

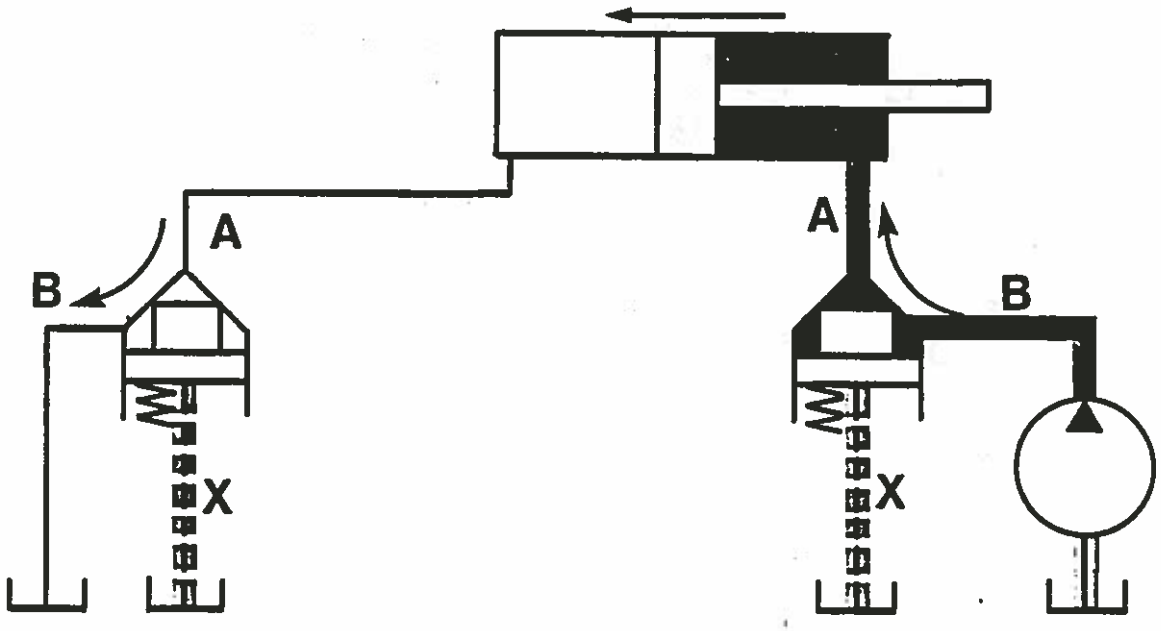


FIGURE NO.14

To retract the cylinder the pump output must be directed to the rod end while the cap end is connected to tank. One pair of cartridge valves will provide these flow paths. The X ports are open to tank at this time.

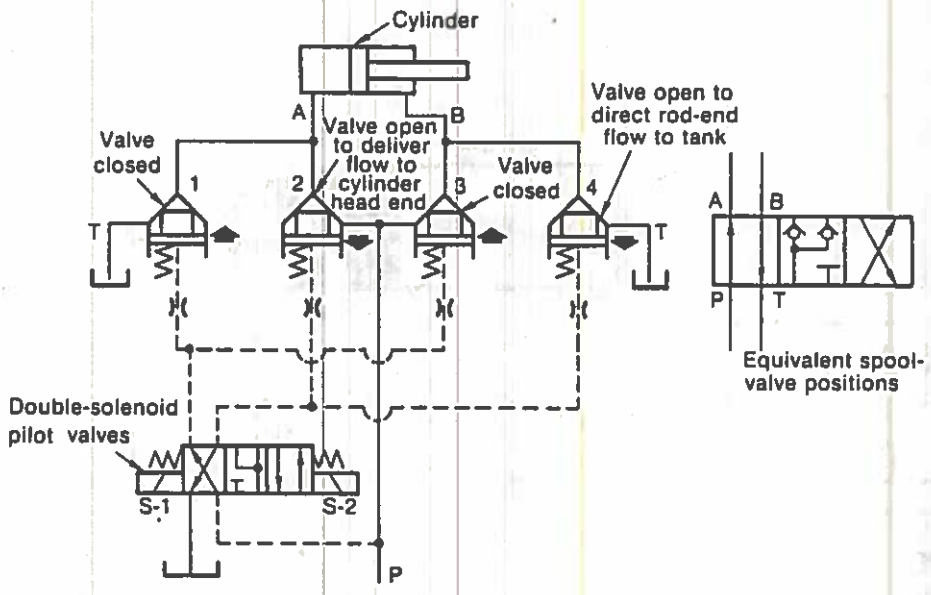


Figure No. 15

This circuit drawing shows the four cartridge valves from the two previous figures piloted by one double-solenoid spring centered spool valve. Pilot pressure is.obtained by teeing off the main system pressure line and is applied to each cartridge pilot chamber when the pilot valve solenoids are de-energized. The pilot chambers of cartridges 1 and 3 are interconnected, as are the pilot chambers of cartridges 2 and 4, so that the valves in each pair open or close simultaneously. This is essentially a closed-center circuit becauce all four cartridges are closed when the pilot valve solenoids are de-energized.

Energizing solenoid S-1 drains the pilot connections of cartridges 2 and 4 while maintaining pilot pressure on cartridges 1 and 3. System pressure acting over the B area of cartridge 2 forces the valve open, directing pump flow to the cap end of the cylinder.

FIGURE NO. 15 (cont'd)

Return flow from the cylinder rod end passes to the tank over cartridge 4 when rod-end pressure is high enough to overcome the spring acting against the cartridge valve poppet. The piston of the cylinder moves to the right. Energizing solenoid S-2 produces the opposite movement.

With a small pilot directional valve you are able to control large main system flows and get three distinct positions as shown at the righ-hand side of the drawing. It shows the parallel paths, the crossed arrow paths, and a center condition. Note that in the center condition a check valve is shown in each cylinder port line. This is done to indicate that when neither solenoid is energized an external force pushing on the piston rod could cause valve #2 to open. Such will happen when the cylinder cap-end pressure exceeds the system pressure. In that case the system pressure acting on the B area plus slightly more than system pressure acting on the A area will combine to overcome system pressure acting on the AP area. (If the rod is pulled instead of pushed valve #3 rather than valve #2 will open). Flow will result and the cylinder piston will move.

If the pump is unloaded or shut down, pilot pressure is lost and each cartridge can open when its spring force is overcome. This condition is not acceptable when vertical loads or external cylinder forces can be high enough to produce cylinder movement.

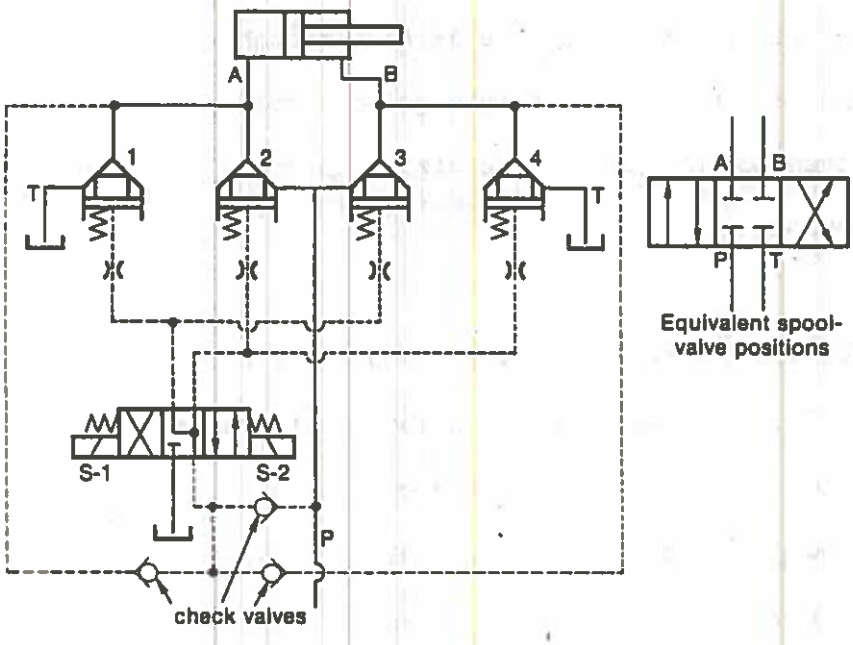


Figure No. 16

To overcome this problem three small check valves are added as shown in figure 16. The check valves allow the highest available pressure to act as the pilot pressure. Thus a closed center system is created.

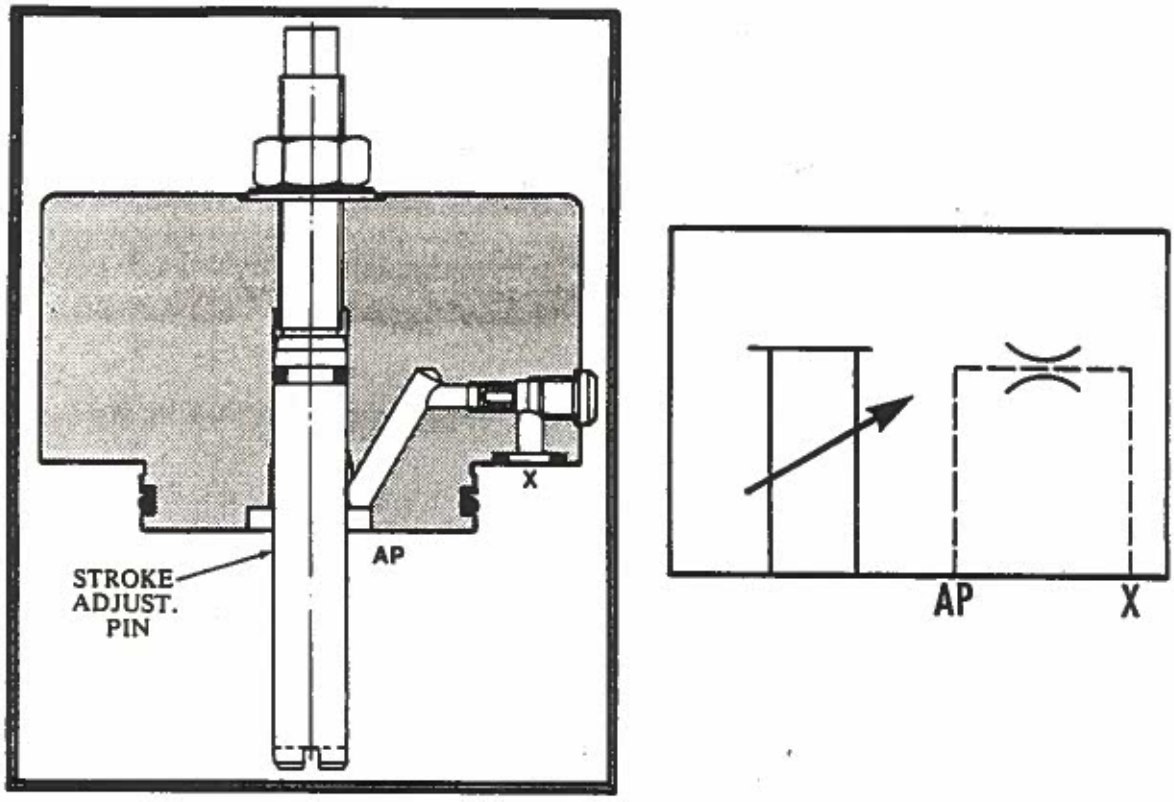


FIGURE NO 17

STORKE ADJUST COVERS

A cartridge valve with stroke adjust cover is used to provide flow regulation and directional control in a single unit. Flow regulation is obtained by limiting the travel or stroke of the main poppet. In this way an adjustable throttle or variable orifice is created.

The throttle opening is set by the position of a pin which extends into the insert spring chamber. The pin forms a stop for poppet opening. the arrangement of parts with standard screw and locknut adjustment is shown below.

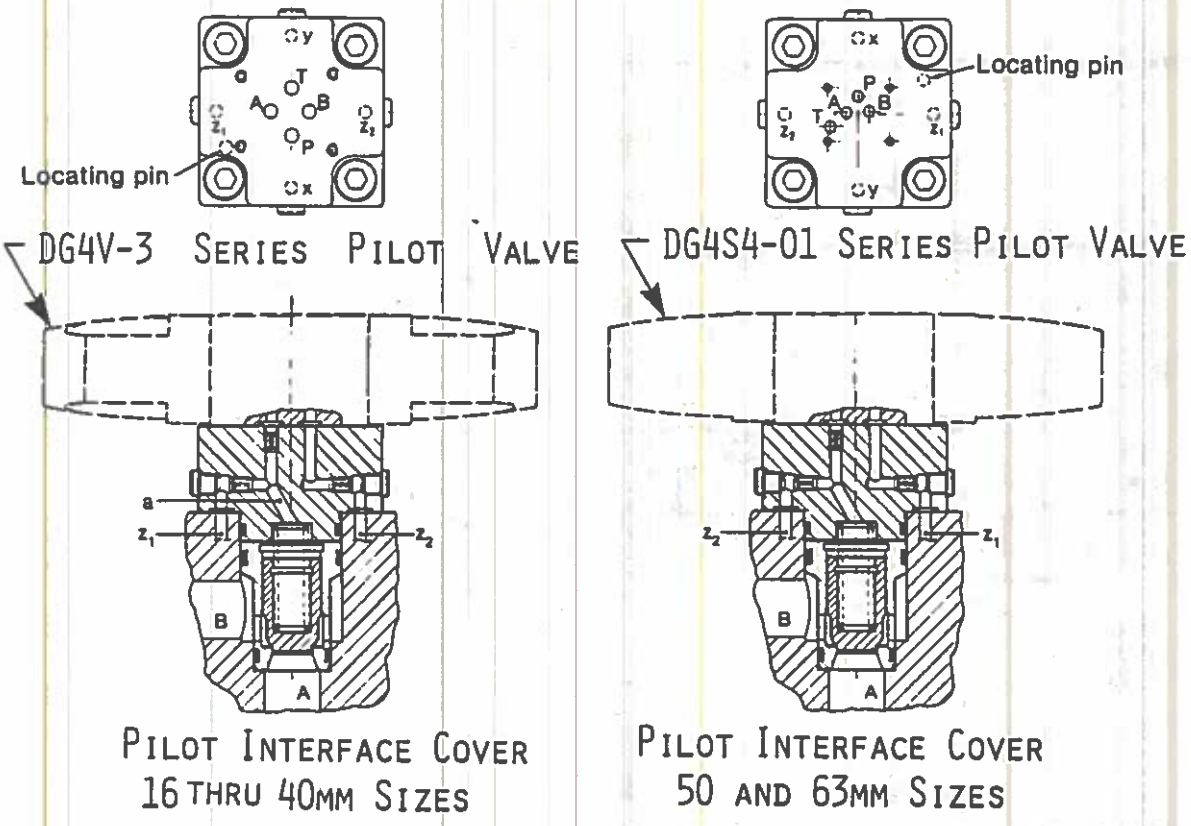
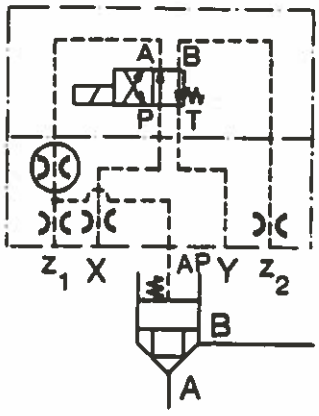


Figure No. 18

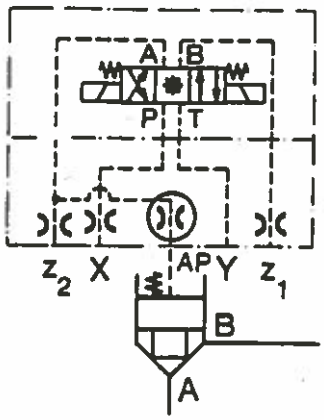
COVERS WITH PILOT VALVE INTERFACE

Covers with a pilot directional valve interface are available in all sizes except. The 16, 25 and 40mm covers have an NFPA D-Ø1 face for mounting a DG4V-3 pilot valve. The 5Ø and 63mm covers have a D-Ø2 face which takes a DG4S4-Ø1 valve.

Note that the 16, 25 and 40mm covers connect auxiliary port Z with the insert spring chamber while the 5Ø and 63mm covers connect the Z2 port with the spring chamber. This is due to the difference in the pilot valve port patterns. They are shown in the top views.



16 THRU 40MM COVERS



50 AND 63MM COVERS

Figure No. 19

In this figure the cartridge valve covers are shown schematically with pilot directional valves mounted on top. Either single or double solenoid valves can be used. The damping orifices shown circled comes installed in the covers. The other indicated orifices may be installed if needed.

Pilot pressure at the X port is connected in the cover to the P port of the directional valve. The T port is connected to Y which is a drain passage. Auxillary ports Z1 and/or Z2 may be connected in the manifold to other valve pilots to provide simultaneous operation of more than one cartridge valve with one pilot valve.

The schematic of the 16, 25 and 40mm valves shows the pilot valve in the spring-offset position. Pilot pressure from the X port is transmitted through the pilot valve (P to A) to the insert spring chamber thereby holding the cartridge valve closed. When the solenoid is energized, the spring chamber is drained through the pilot valve (A to T) to the Y (drain) port and thus the cartridge valve opens to allow flow in either direction.

VALVE RESPONSE

Valve response, the timing and rate of opening or closing of the main valve poppet, is a function of the damping orfice size and the system pressures applied to the "a", "B", and pilot pressure ports of the valve. In most cases the standard orifice supplied in the cover will give satisfactory valve response. If needed, critical machine functions can be optimized or tuned by changing the appropiate damping orifice sizes to modify valve response. Larger orifices give faster response (and less damping); smaller orifices give slower valve action. Orifice plug kits include several size orifices plus a blank plug. The use of orifices smaller than Ø.8mm (.Ø32 in.) diameter is not recommended for most hydraulic systems due to possible clogging by system contamination.

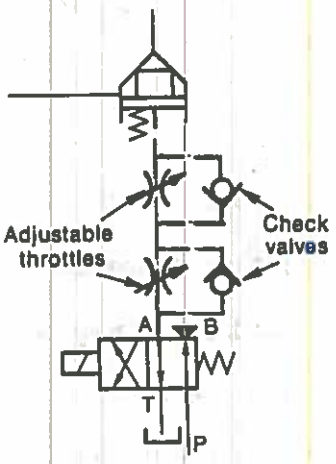


FIGURE 2Ø

A moduler block maybe used with a directional valve cover to provide an adjustable response of the main poppet.

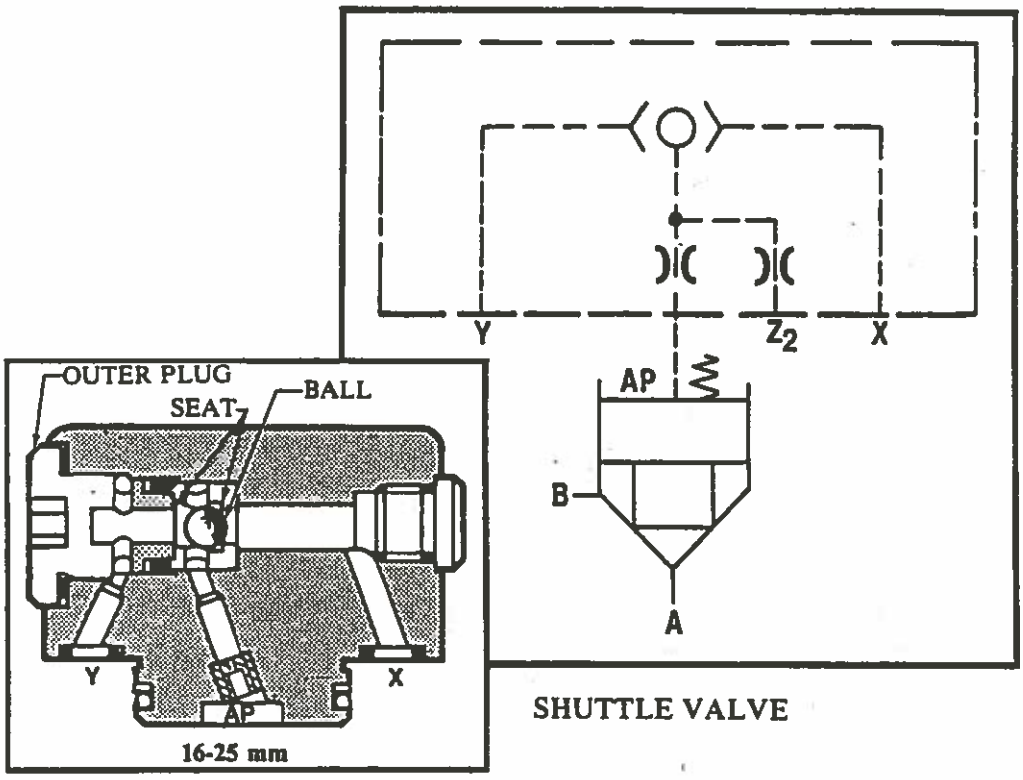


FIGURE NO 21 SHUTTLE VALVE COVERS (Standard)

A shuttle valve cover takes the higher of two pilot pressures and directs it to pilot spring area AP. A schematic diagram of the shuttle valve is shown here. The X port and the Y port feed fluid to each end of the shuttle., The spring chamber (area AP) is connected to the center section of the shuttle. The Z2 port is also connected to the center section of the shuttle.

A seat is pressed into the cover bore and a ball is inserted. The outer plug is then threaded into the cover. The shuttle valve ball seat which prevents flow between AP and Y is machined on the end of the outer plug. An "O" ring and back-up ring located on the plug, prevent leakage between the AP and Y port areas; another "O" ring prevents external leakage.

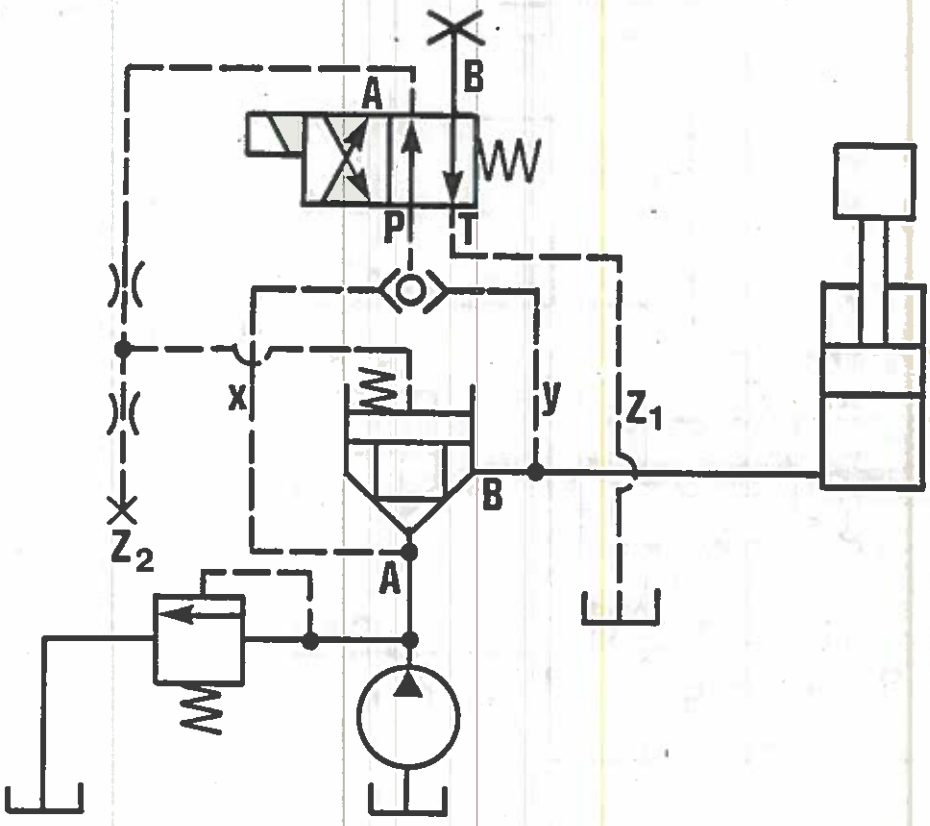


Figure No.22

When the system requires an on/off valve with flow capabilities in either direction a shuttle cover with directional valve interface may be used as shown in this figure.

When the solenoid is de-energized, the highest pressure in port X or Y is transmitted through the shuttle valve to the poppet spring area. Thus the valve will close whether A and B are at equal or unequal pressures because the spring force added to the higher of the A or B pressures will overcome the A and B pressures trying to open the valve.

FIGURE NO. 22 (cont'd)

Energize the solenoid and the poppet spring chamber is drained. Now fluid can travel in either direction as long as it has enough energy to overcome the spring holding the poppet closed.

To convert this circuit from "normally closed" to "normally open" replace the right hand spring offset valve with a left hand model. This will change the spring offset path from P - A to P - B.

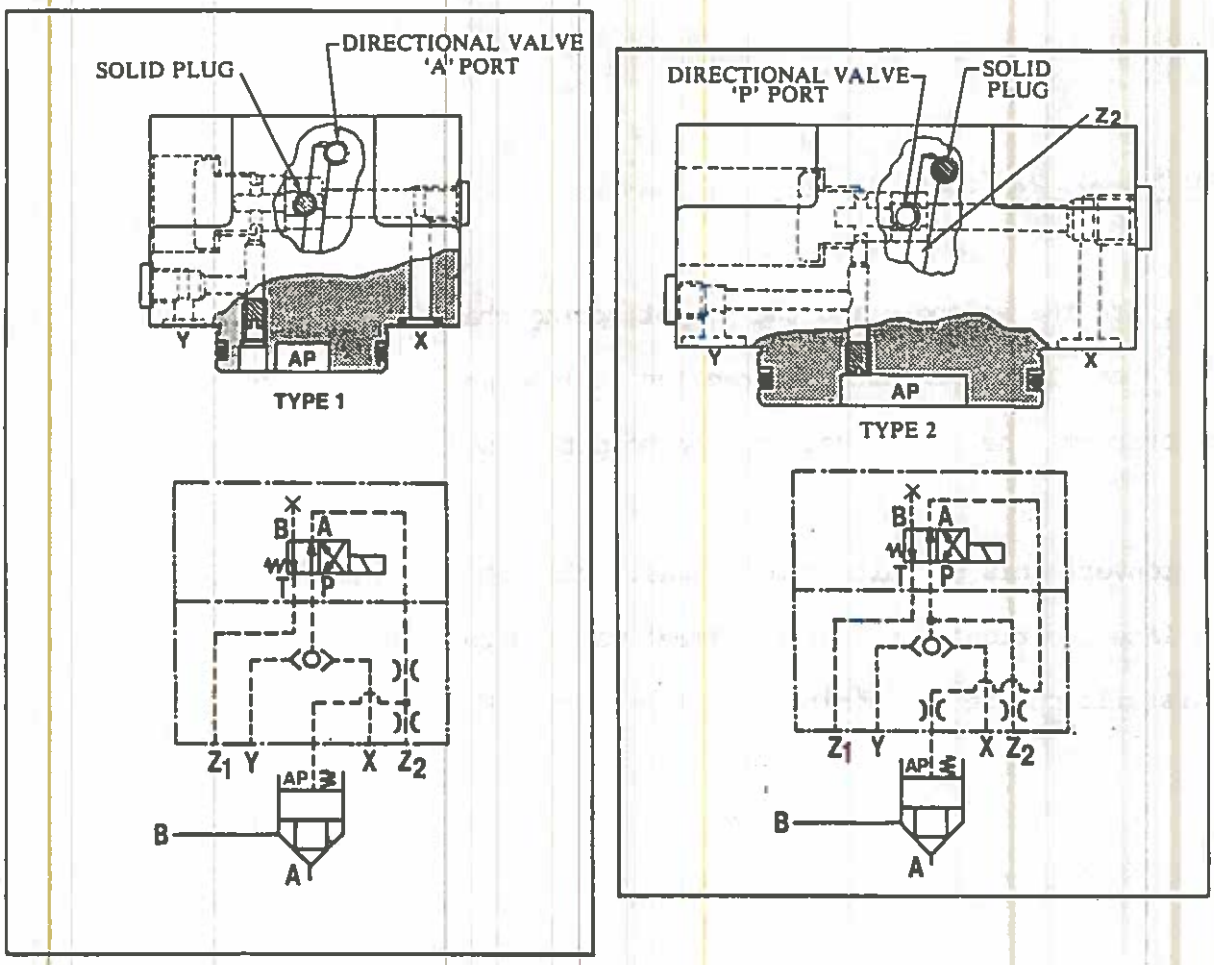


FIGURE NO. 23 SHUTTLE VALVE COVERS WITH NFPA-DØ1 INTERFACE

A shuttle valve with a directional valve mounted on its NFPA-DØ1 interface expands a basic check valve to a check/on/off device. Shuttle covers are available in the 25, and 40mm sizes. They are not available in the 5Ø and 63mm sizes. Two configurations of the shuttle valve are available, type 1 and type 2. The difference between the two is an assembly change which picks up the Z2 port from a different location in the cover. The change from one assembly configuration to the other is made by exchanging the location of a solid plug. This plug is not visible without removing external plugs from the cover.

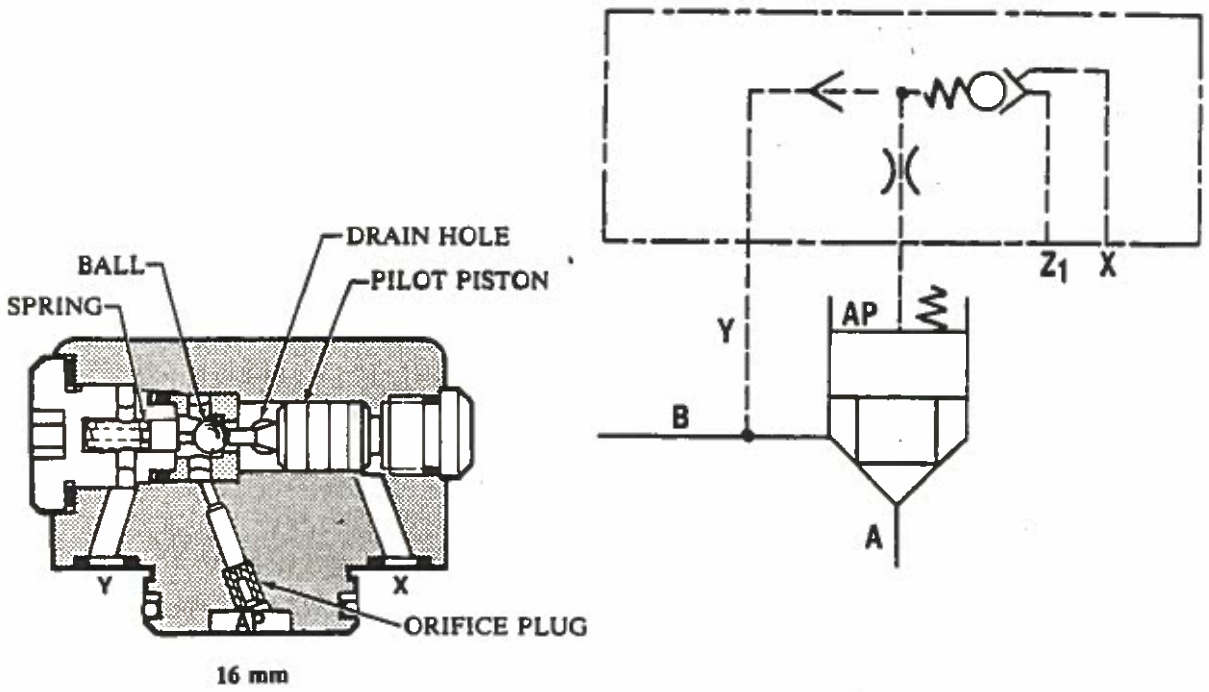


FIGURE NO 24 PILOT OPERATED CHECK COVER

The pilot operated cartridge check valve can be applied in much the same manner as other pilot operated checks. Three pilot ports are used:

1. The X port is drilled in the manifold to the pilot signal.
2. The Y port is drilled in the manifold to connect with the B port of the insert kit.
3. The Z1 port is connected to a drain line. When there is no X pilot signal to the valve, we have a simple check valve. Flow can pass from A to B if the pressure in the A port is greater than the sum of the pressure in the B port plus the spring force. Flow is blocked from B to A.

FIGURE NO. 24 (cont'd)

When sufficient pilot pressure is applied to the X port, the piston moves, lifting the check valve ball from its seat. This drains pilot spring area AP and closed the passage between area AP and Y. If the A port is pressurized, flow will pass from A to B regardless of the area ratio of the insert kit. If B port is pressurized, flow will pass from B to A providing the area insert kit ratio is 1:1.1 to 1:2.

The cartridge valve B port is connected to Y. When flow reverses, pressure is applied to Y from the B port and removed from X. The spring then shifts the check valve ball which blocks the passage to the Z1 port and the AP area is pressurized preventing the cartridge valve from opening. The pilot piston has an area 3.4 times the seat area of the check valve. This means that when system pressure is 3.4 times the pilot pressure, the pilot piston and ball are in pressure balance.

Make sure a pressure greater than one third (1/3) of system pressure is available for use as pilot pressure. The maximum allowable pilot pressure is 5000 PSI.

The pilot operated check valve is available in the 16mm, 25mm and 40mm sizes.

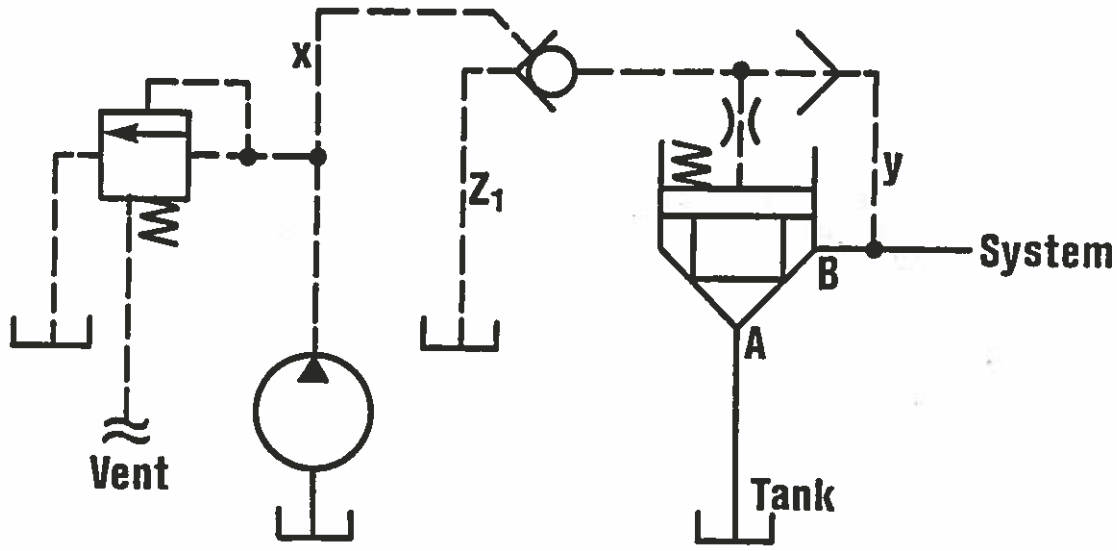


FIGURE NO. 25 PILOT OPERATED CHECK VALVE

It is important to remember that the 3.4:1 pressure ratio of pilot pressure to system pressure is in effect not only when the pilot valve ball is to be unseated but also when the pilot signal is removed to allow the ball to re-seat. This pressure relationship can cause a problem as is shown in this circuit. The designer of the circuit intended that the cartridge poppet would open B to A when pilot pressure from a separate source is applied to the pilot operated check via the X port. Closing the poppet was to be done by venting the pilot pressure relief valve.

The first operation, opening B to A, worked OK. However, when the relief valve was vented, the cartridge valve poppet did not close because the system pressure acting on the small ball area was not high enough to overcome the relief valve vent pressure acting on the larger (3.4:1) pilot piston area.The following figure shows one solution to this problem.

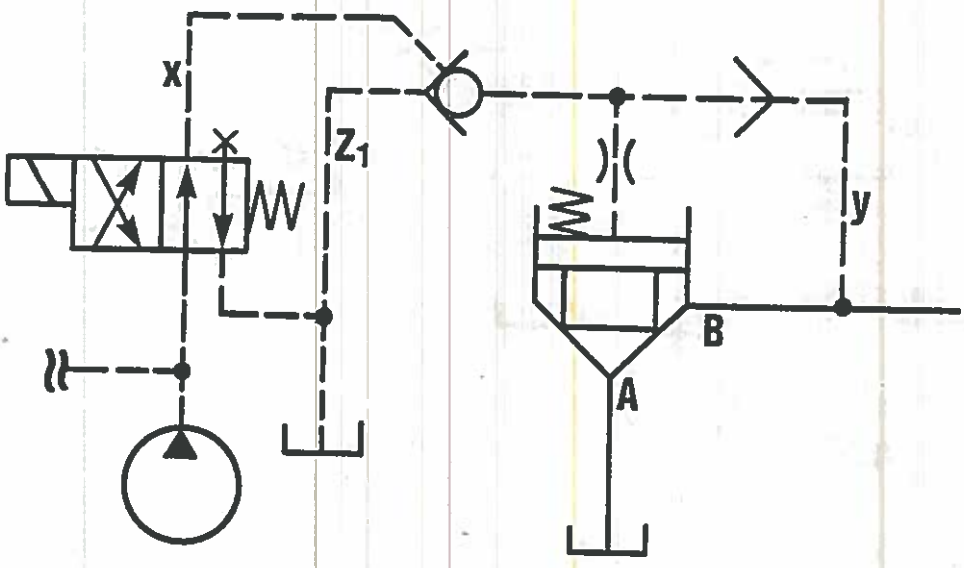


FIGURE NO. 26

The fix was to use a directional valve to apply or drain the pilot pressure. The tank port of the directional valve was connected to drain so the pilot pressure at the pilot piston did go to zero, allowing system pressure to close the cartridge valve,returning the main system to full operation.

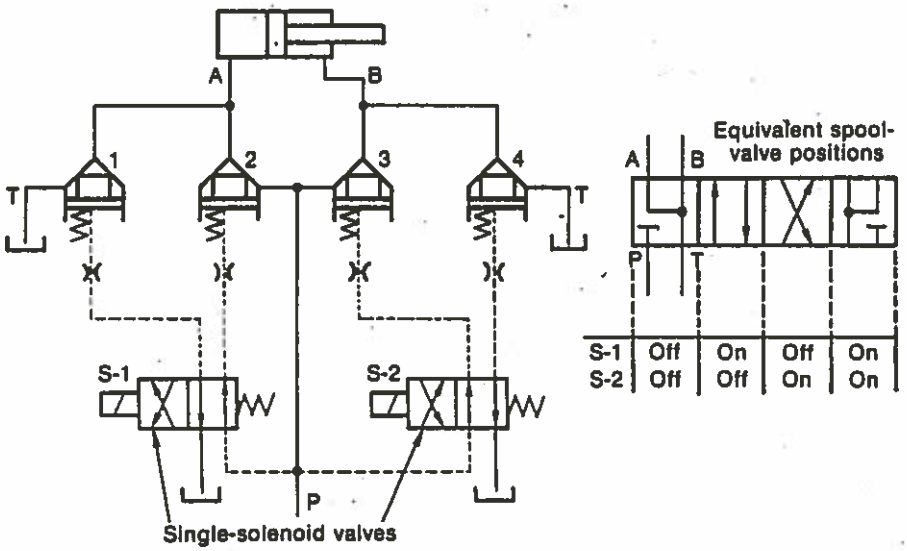


Figure No.27

This figure shows how the cylinder in the four cartridge circuit can be operated regeneratively without adding more solenoids. Simply replace the three-position, double solenoid pilot valve with two, two-position, single solenoid valves. When the two solenoids are energized simultaneously the cylinder will operate in a regenerative manner.

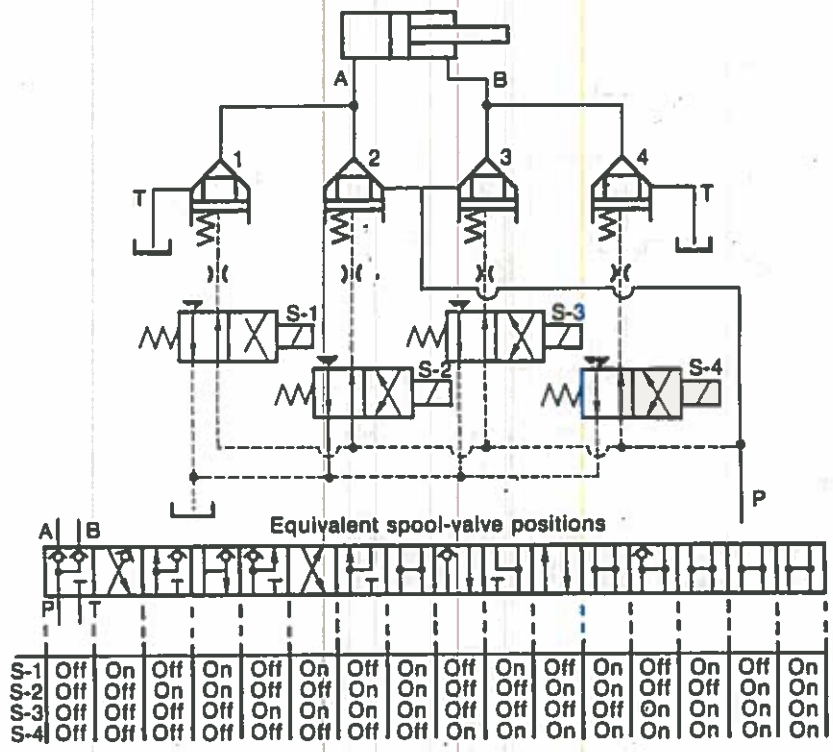

A
B
1
2
3
4
T
T
S-1
S-2
S-3
S-4
P
Equivalent spool-valve positions
A
B
P
T
S-1 Off On Off On Off On Off On Off On Off On Off On Off On
S-2 Off Off On On Off Off On On Off Off On On Off Off On On
S-3 Off Off Off Off On On On On Off Off Off Off On On On On
S-4 Off Off Off Off Off Off Off Off On On On On On On On On

Figure No. 28

Add just two more two-position, single solenoid valves to create an independent-control circuit. Operating each cartridge valve with a solenoid valve creates the equivalent of a sixteen-position spool valve. This arrangement enables each cartridge to be controlled independently, allowing a smooth transition from one operating phase to the next.

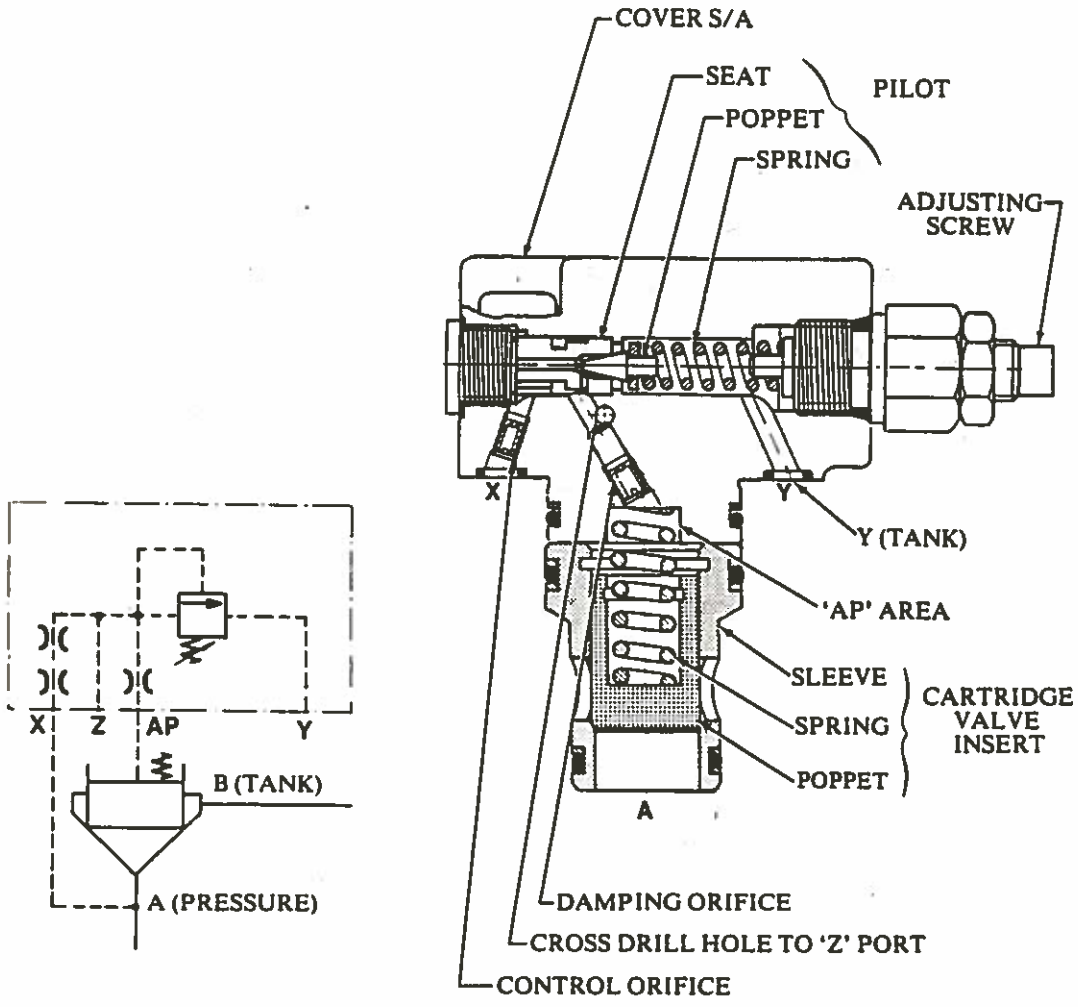


FIGURE NO.29 CARTRIDGE RELIEF VALVE

A cartridge relief valve performs in the same manner as the traditional type relief valve. It is a two-stage or compound relief valve. In the traditional relief valve, the pilot sensing port is a .040 inch hoile through the spool. In the cartridge relief the pilot sensing line is taken through the manifold, around the main stage, then through a .040 orifice in the cover.

Note the three pilot connections from the manifold to the cover. X is the pilot pressure connection. Y is the drain connection. Z is the vent connection.

FIGURE NO. 29 (cont'd)

Flow through the main stage is from A to B. Therefore, the X pilot port is connected to the A port. The Y is the drain connection. Z is the vent connection. Flow through the main stage is from A to B. Therefore, the X pilot port is connected to the A port. The Y port may be connected to B or to an external drain. Just as in traditional relief valves, any back pressure in the drain port will add directly to the setting of the valve.

The Z port may be drilled in the manifold to connect to a vent control or a remote pressure pilot. If it is not needed, it is simply not drilled in the manifold.

The recommemded maximum flow for each valve size is:

SIZE	FLOW	
	L/MIN	GPM
16mm	160	42
25mm	400	105
40mm	700	185

These flow rates are based on 4 bar pressuredrop with valve unloaded.

Three pressure ranges are available. The maximum pressure is changed by changing the spring in the pilot section. The main stage spring remains the same in all cases. By changing the pilot spring, we canachieve a maximum setting of 125 bar, 245 bar, or 350 bar(1800, 3500, or 5000PSI respectively).

FIGURE NO. 29 (cont'd)

PRINCIPLES OF OPERATION

The pressure setting of the valve is determined by the position of the adjusting screw which varies the spring compression.

In normal operation, the B port is connected to tank. The A and X ports are interconnected within the manifold. System pressure is present at A.

The system pressure at the A port is fed to the X port and communicated through the control orifice into area AP. Area AP is located directly above the cartridge insert poppet. This allows the cartridge insert poppet to be in hyeraulic balance and held against its seat by a light spring. Note: The orifice located in the AP area feed passage is used to slow reaction time of the spool and this prevents instability.

When system pressure at A exceeds the cover spring setting it forces the pilot poppet away from its seat. Fluid will flow through the control orifice, across the poppet and through the Y port to tank. Flow through the control orifice develops a pressure drop that subtracts from system pressure. The orifice pressure drop prevents pressure in the AP area from rising above the pilot poppet cracking pressure. When system pressure at the A port exceeds the pressure of the AP area sufficiently, the cartridge poppet will lift and throttle fluid from A to B, This limits system pressure at A.

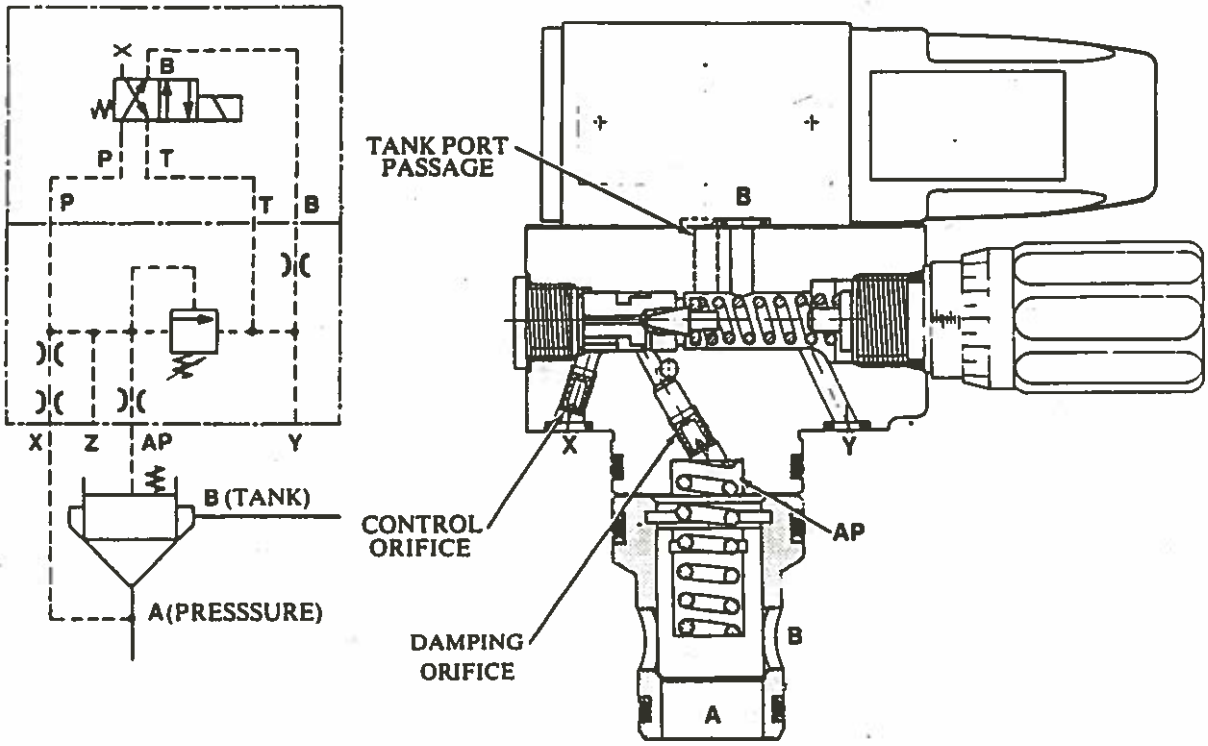
FIGURE NO. 29 (cont'd)

VENT FUNCTION

Venting the valve by opening the AP area to tank will permit flow to occuir from A to B at a pressure of approximately 5 bar.

Note: Vent pressure is limited only by the light spring of the cartridge poppet plus any back pressure present in the vent line. The AP area is connected internally within the cover to the Z port. Opening the Z port to tank vents the valve.

FIGURE NO. 30



VENTING THE RELIEF VALVE

The picture shows how a solenoid valve can be used to vent a cartridge relief valve.

The spring-offset, single solenoid directional valve is bolted onto the interface of the cartridge valve cover. When the solenoid is de-energized, the relief valve is vented to tank thru the solenoid valve's P and B ports. When the solenoid is energized the P port is blocked causing the cartridge relief valve to return to its pre-set pressure.

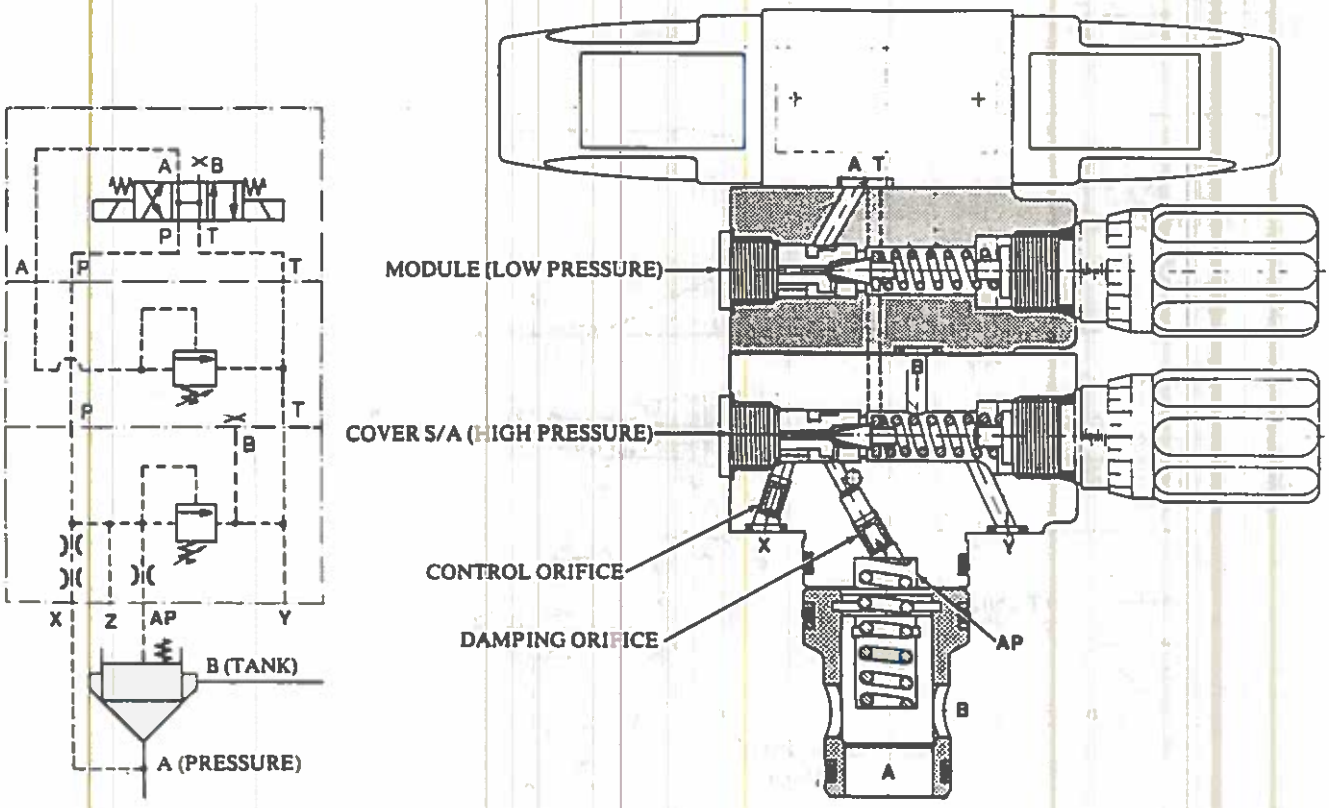


FIGURE NO. 31 DUAL PRESSURE SETTINGS PLUS VENTING

In this arrangement, a spring centered directional valve controls two relief valve pilot stages to provide two different relief pressures. Also, when the solenoids are de-energized, the relief valve is vented to tank. The Z port is a remote vent connection. Block the Z port if the remote vent feature is not used.

The high pressure setting is controlled by the pilot valve located in the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. At least a 10.3 bar (150 PSI) spread is required between the high and low pressure setting to prevent oscillation between the two pressure settings.

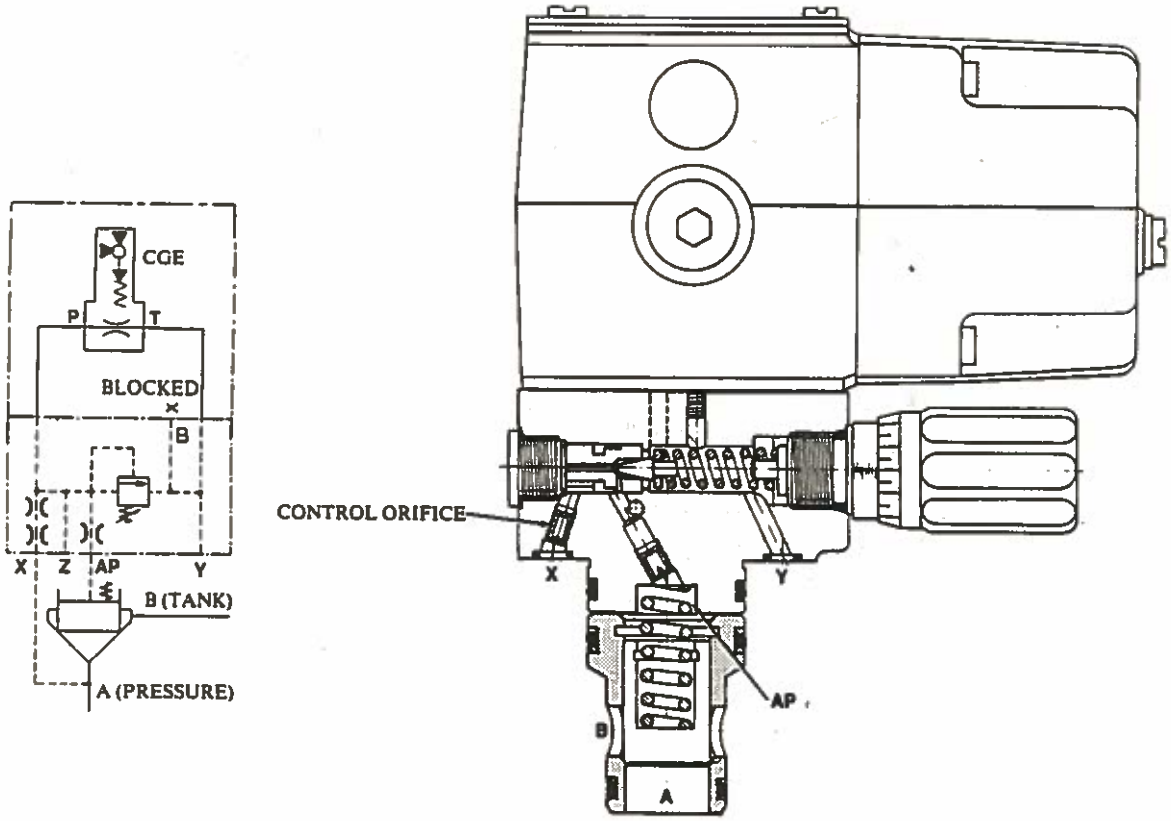


FIGURE NO. 32 ELECTRICALLY MODULATED RELIEF VALVE

The cartridge valve interface cover accommodates the CGE-Ø2-*-2Ø electrically modulated relief valve. This valve can be remotely controlled by a micro-computer or a regulated power supply with appropriate voltage and current control. As current increases, pressure drop across the CGE valve increases. This will cause the system pressure to increase proportional to current change up to the manually set pressure of the cartridge relief valve. That's because the pressure drop across the CGE valve cannot exceed the manual pressure setting of the cartridge valve.

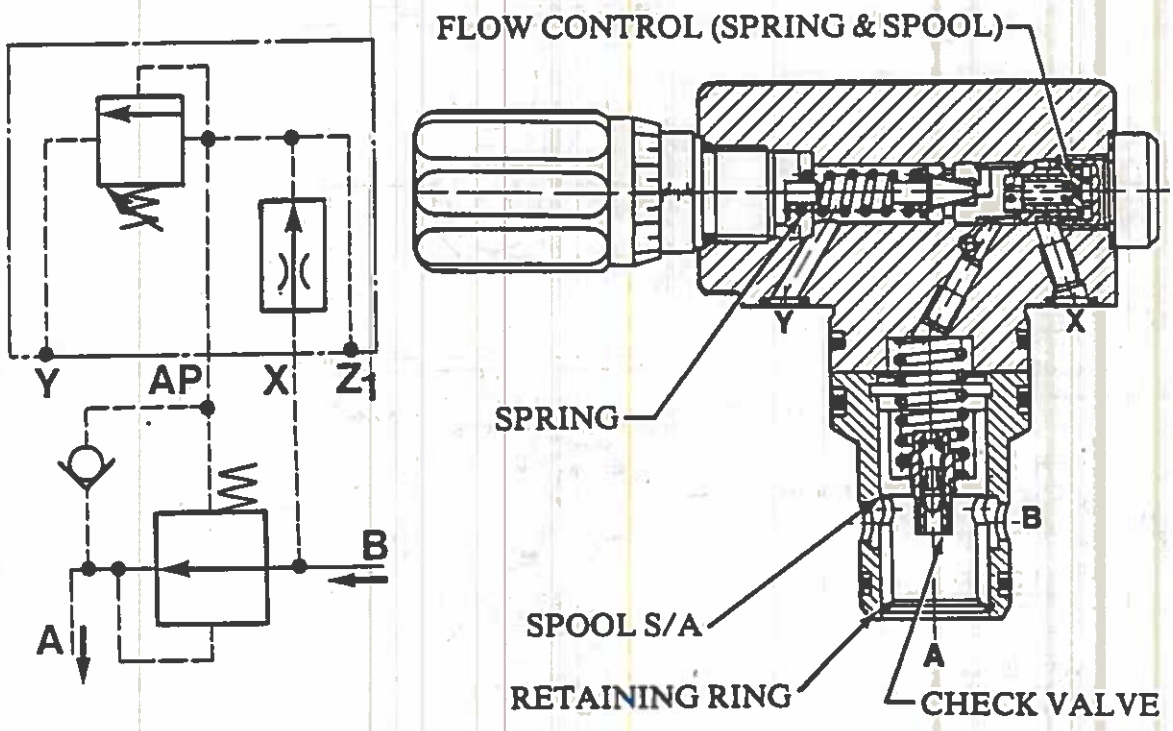


FIGURE NO. 33 PRESSURE REDUCING VALVE

The pressure reducing valve in the cartridge valve family operates in much the same manner as the traditional type of pressure reducing valve. Even its construction is similar. It has a pilot stage which consists of an adjusting screw, spring, poppet, and seat with integral flow control to limit flow through trhe pilot stage. It has a main stage which consists of a sliding spool, spring offset to the open position. Flow direction is only one way, from port B to port A.

FIGURE NO. 33 (cont'd)

In operation, the A port is connected to the load and the B port is connected to the pressure source The B and X ports are interconnected within the manifold. System pressure at B is fed to the X port and communicated through a pressure compensated flow control into area AP. This flow control in the cover limits flow to the pilot stage. The flow control spring and spool act as a hydrostat to control a variable orifice which holds a constant pressure drop across the fixed orifice.

Thus, there is a constant flow thru the pilot stage regardless of main system pressure at B port during the reducing valve operation.

The main stage spool is spring loaded to the open position with equal pressure at the top and bottom of the spool until load pressure increases to the pilot stage setting. With the pilot stage limiting the pressure at the top of the main stage spool and load pressure rising to equal the spring force plus the pressure on top of the spool, the spool will move up restricting the flow to the load. Thus, the maximum pressure at the load will be the pilot stage setting plus the spool spring force.

The valve can be vented by opening the Z1 port.

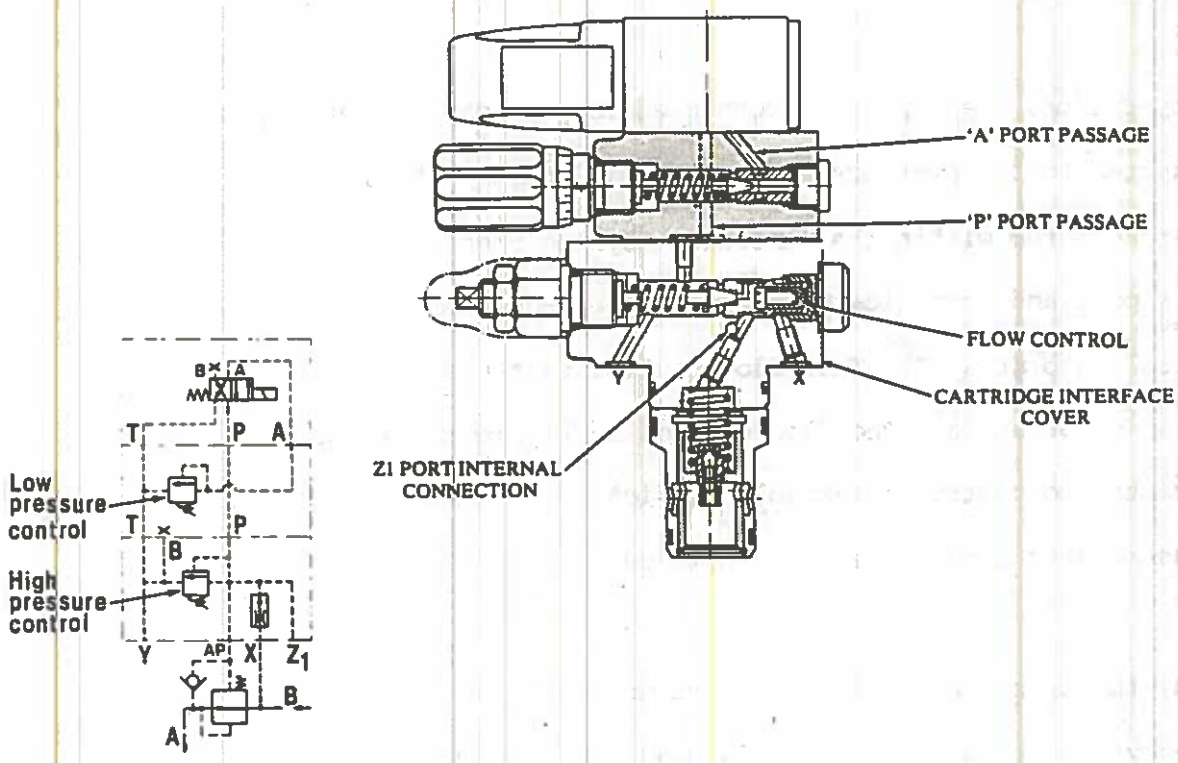


FIGURE NO. 34 PRESSURE REDUCING VALVE WITH HIGH AND LOW ADJUSTABLE SETTINGS BY ELECTRICAL SELECTION

In this valve assembly a left hand, spring offset directional valve controls two reducing valve heads and provides two different reduced pressures.

The highest pressure setting is controlled by the pilot valve located in the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. When the directional valve is in the spring offset condition (solenoid de-energized),

FIGURE NO. 34 (cont'd)

the high pressure setting is active. Provide at least 10.3 bar (150 PSI) spread between the high and low pressure settings to prevent oscillation between the two pressures.Use a standard spring offset valve (offset P to A) to have the low pressure setting functional in the spring offset condition. If a standard valve is used, check installation dimensions to make sure a physical problem does not exist. The standard valve's solenoid will be directed away from the adjuster mechanism.

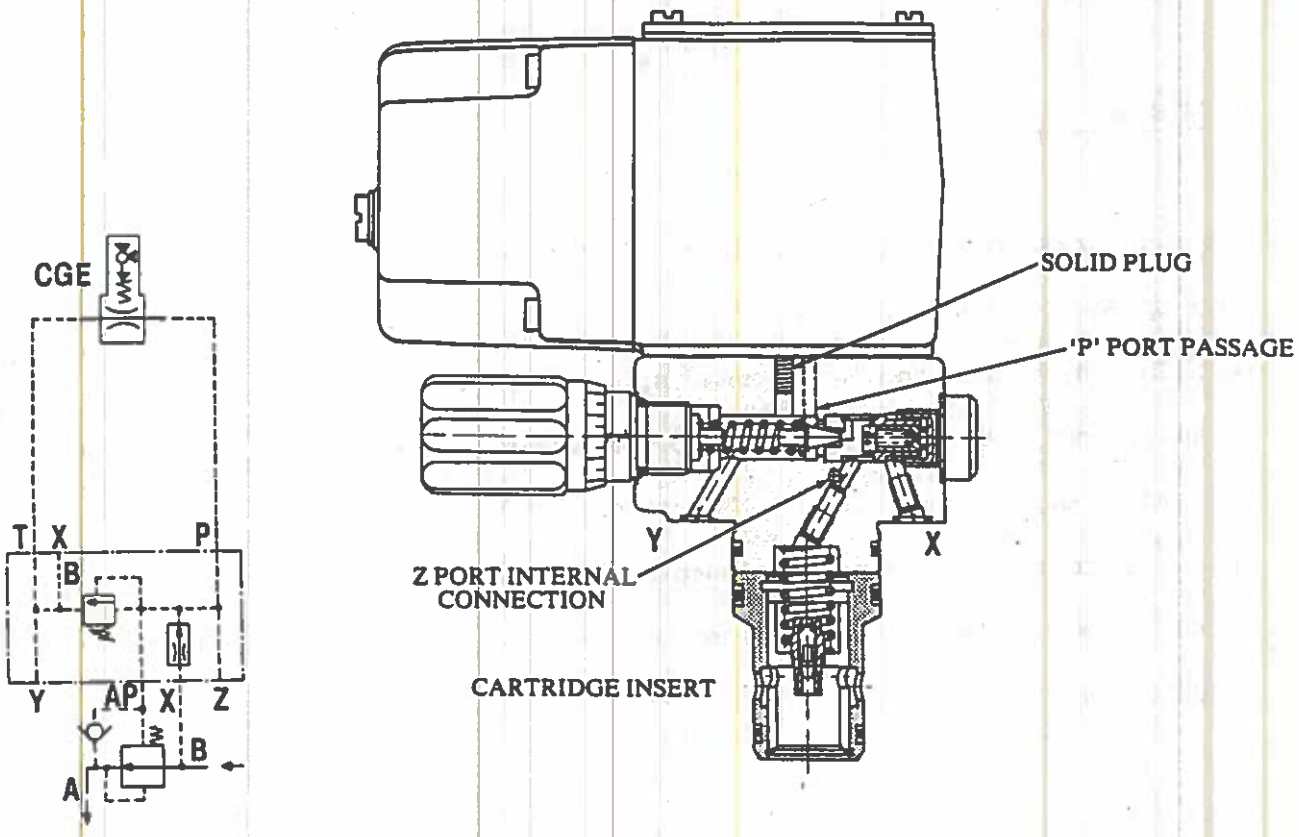


FIGURE NO. 35 ELECTRICALLY MODULATED PRESSURE REDUCING VALVE

FUNCTION

The cartridge valve interface cover accommodates the CGE-Ø2-*-2Ø electrically modulated relief valve. This valve can be remotely controlled by a micro-computer or a regulated power supply with appropriate voltage and current control. As current increases, pressure drop across the CGE valve increases. This will cause the pressure reducing valve pressure to follow the CGE valve. The maximum setting of the cartridge valve is limited by the setting of the manual adjuster located in the cartridge valve section.

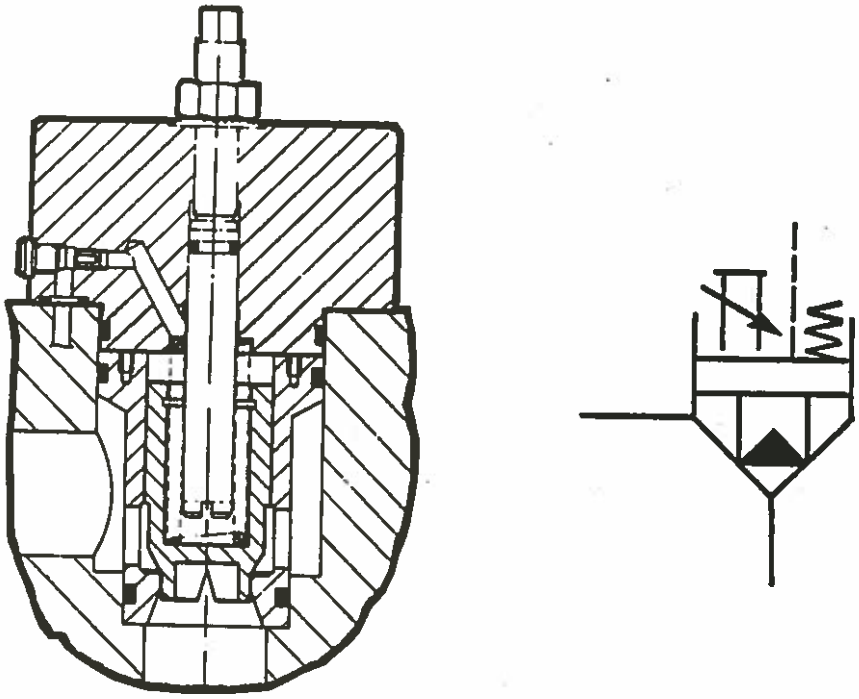


FIGURE NO. 36 FLOW CONTROL VALVES

Flow control valves fall into two basic categories: pressure compensated and non-pressure compensated. The latter are used where load pressures remain relatively constant and feed rates are not critical. They may be as simple as a fixed orifice or an adjustable needle valve.

A cartridge valve with stroke adjustment cover and notched metering poppet provides non-pressure compensated control of flow rates in a manner similar to a needle valve. However, the cartridge valve has the additional feature of being able to be turned on or off without changing the throttle setting.

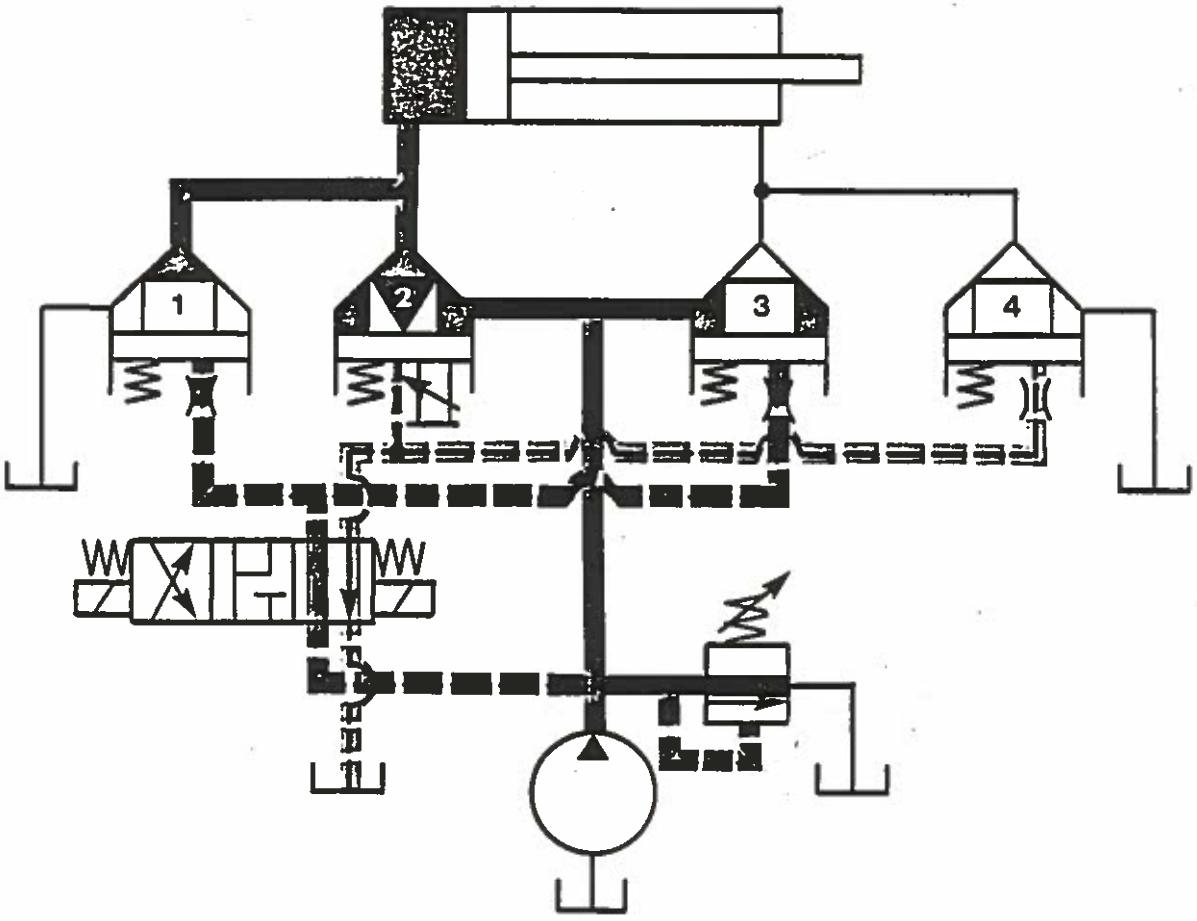
FIGURE NO. 36 (cont'd)

The stroke adjustment cover contains a pin which extends into the cartridge spring chamber. The pin forms a stop to limit the distance the poppet can move off its seat. The pin position is adjusted by a screw which itself is available in four configurations; plain screw adjustment, screw adjustment with cap, micrometer knob, and micrometer knob with key lock.

To indicate that the cover has the adjustable stroke feature the graphical symbol includes a rectangle to show manual operation and an arrow to show adjustability.

To provide good control of the flow through a cartridge valve the stroke adjustment cover should be used in combination with a companion poppet. Designed for use with a standard 1:2 area ratio insert, the poppet has a v-notched skirt which has better metering characteristics than a standard poppet. The trade-off to this is a substantial reduction in the flow rate at 5 bar differential pressure.

FIGURE NO. 37 METER IN CIRCUIT



Here is an application of the stroke adjustment cover with v-notched metering poppet. It controls the speed of the piston by metering the flow of oil into the cap-end of the cylinder. This is a non-pressure compensated meter-in system.

If the piston is to control an overhauling load it is necessary to limit the flow rate of the oil leaving the rod-end of the cylinder. To do that, put the stroke adjustment cover on valve number 4 instead of valve number 2. Also, install a shuttle valve in the supply line to the solenoid valve. Connect the shuttle valve to both the rod-end port of the cylinder and to the pump. This assures enough pressure to keep valve 3 closed when the piston is extending.

BY-PASS TYPE FLOW CONTROL

For more accurate control of flow rates, pressure compensated flow controls may be constructed from standard cartridge valve components.

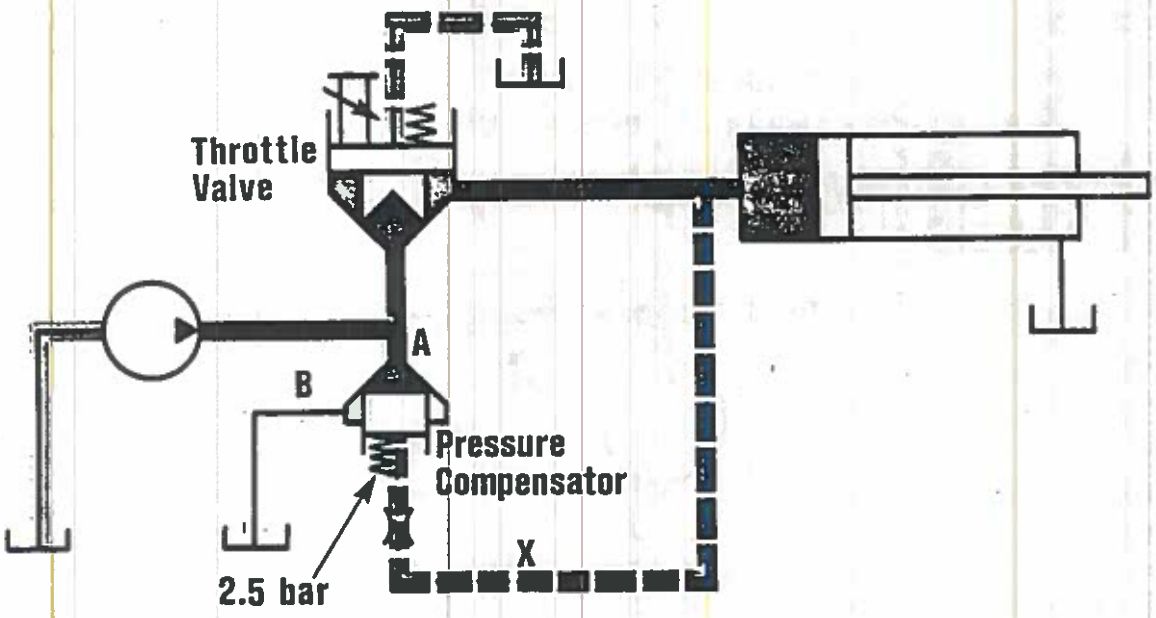


FIGURE NO. 38 BY-PASS TYPE FLOW CONTROL

A by-pass type flow control holds the adjusted flow rate constant by keeping the differential pressure across the throttle constant regardless of load pressure.

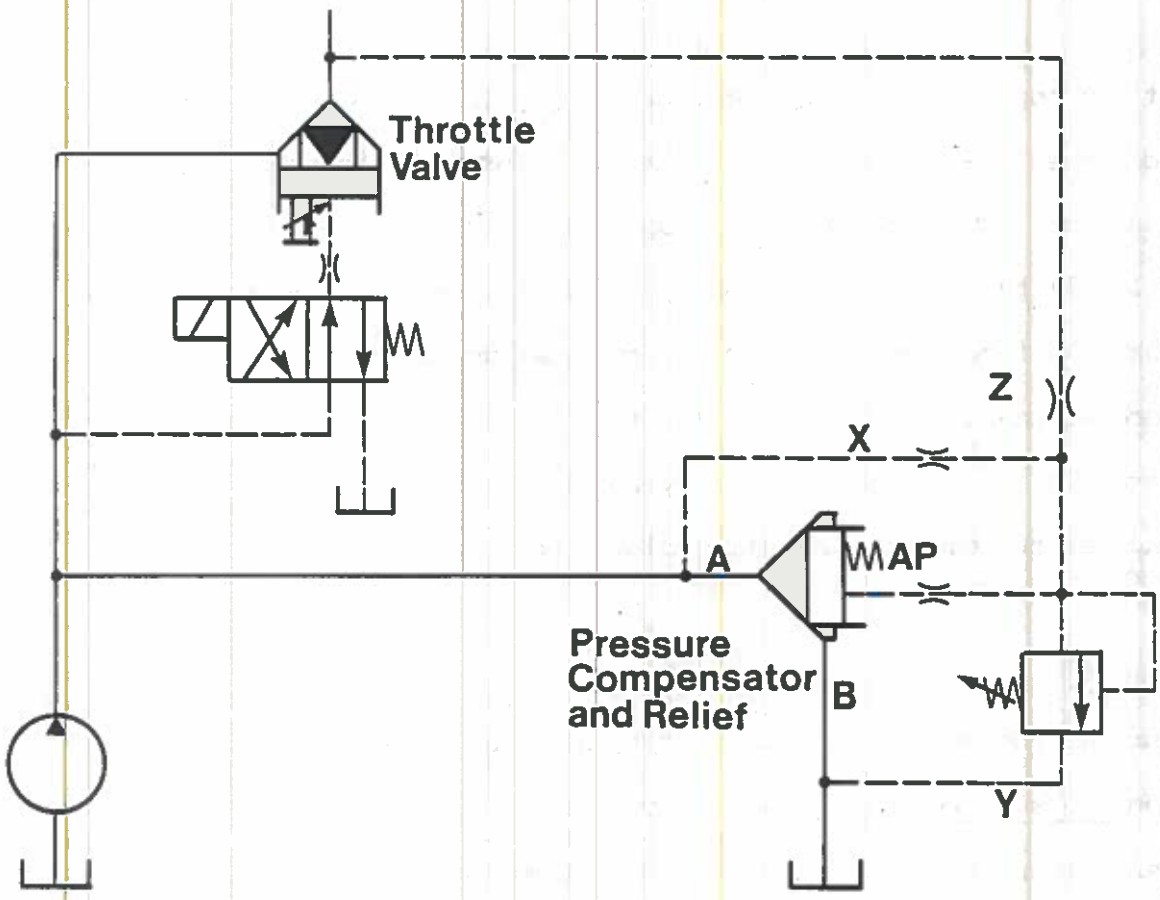
Pressure compensation in a cartridge type, by-pass flow control system is provided by a 1:1 area ratio poppet and standard cover as shown in this figure. The flow through the throttle in the cartridge valve that has a stroke adjustment cover and 1:2

FIGURE NO. 38 (cont'd)

throttling poppet generates a pressure drop. This pressure drop is sensed across the 1:1 insert at the A and X ports of the pressure coompensator. When the pressure drop equals 2.5 bar (the spring force level) the poppet opens and by-passes excess oil from the pump to tank. An increase in load on the cylinder would increase the pressure at the X port. This raises the pressure level upstream of the throttle an equal amount thereby holding constant the pressure drop across the throttle and thus holding constant the flow thru the valve.

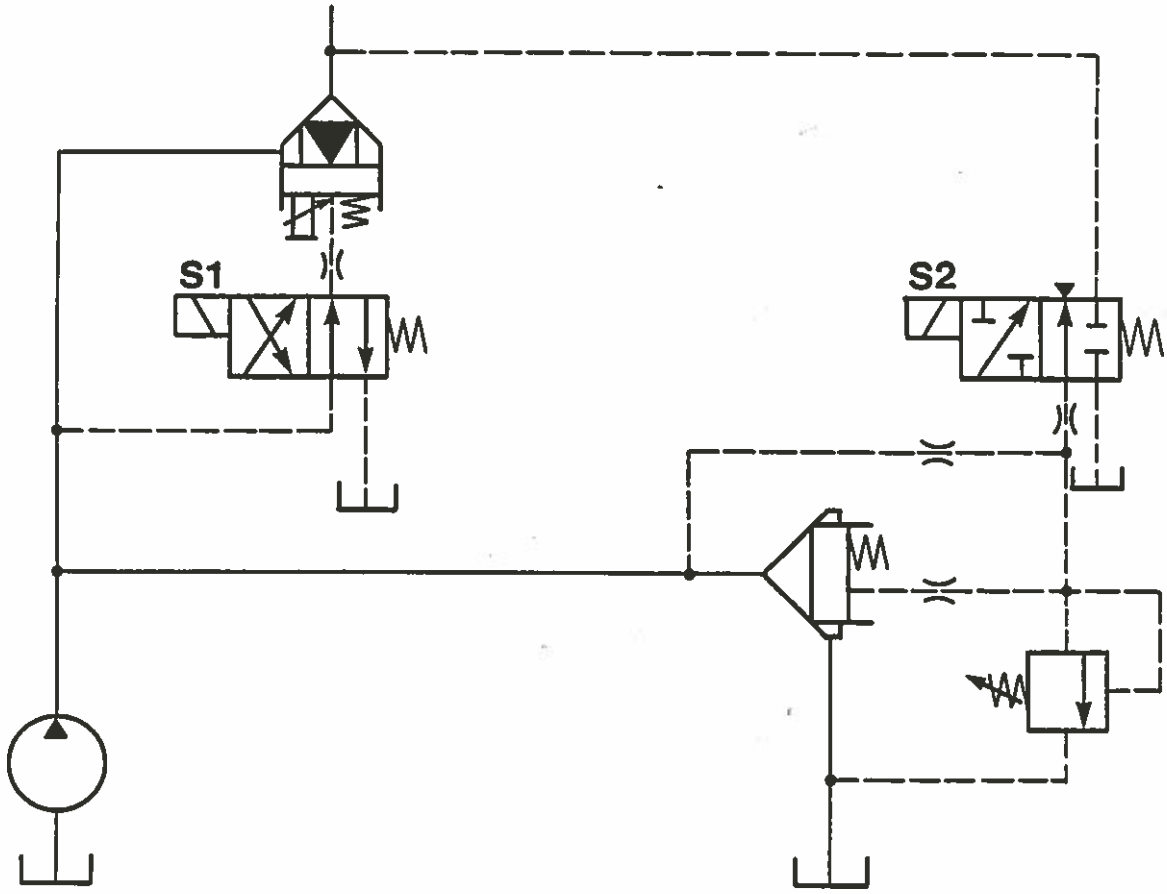
Pressure at the pump will be 2.5 bar higher than load pressure. No maximum pressure limit is provided by this type of flow control. The next figure shows how to limit the maximum pressure.

FIGURE NO. 39



Maximum pressure limitation in a by-pass type,pressure compensated flow control can be provided by replacing the standared cover of the 1:1 insert pressure compensator valve with a relief valve cover. The pilot relief valve will limit pressure in the AP area of the poppet whether it is on the load side of the throttle or on the pump side. When the throttle insert is closed, pilot flow would be from A port through the orifice in the X passage and over the pilot relief valve thereby limiting the maximum system pressure. If the throttle is open and the cylinder is moving, the load pressure plus throttle valve restriction pressure establishes the system pressure.

FIGURE NO. 40



In either condition flow through the pilot passage is from the A port through the X port to the connection of the load sensing passage downstream of the throttle. This flow would cause the cylinder to creep if the throttle was closed with the cylinder Piston creep can be elimintaed by installing a spring offset directional valve in the load sensing line to prevent flow when the throttle poppet is closed.

The by-pass type flow control and relief valve provides accurate flow control plus it saves horsepower because pump pressure is never more than 2.5 bar over load pressure.

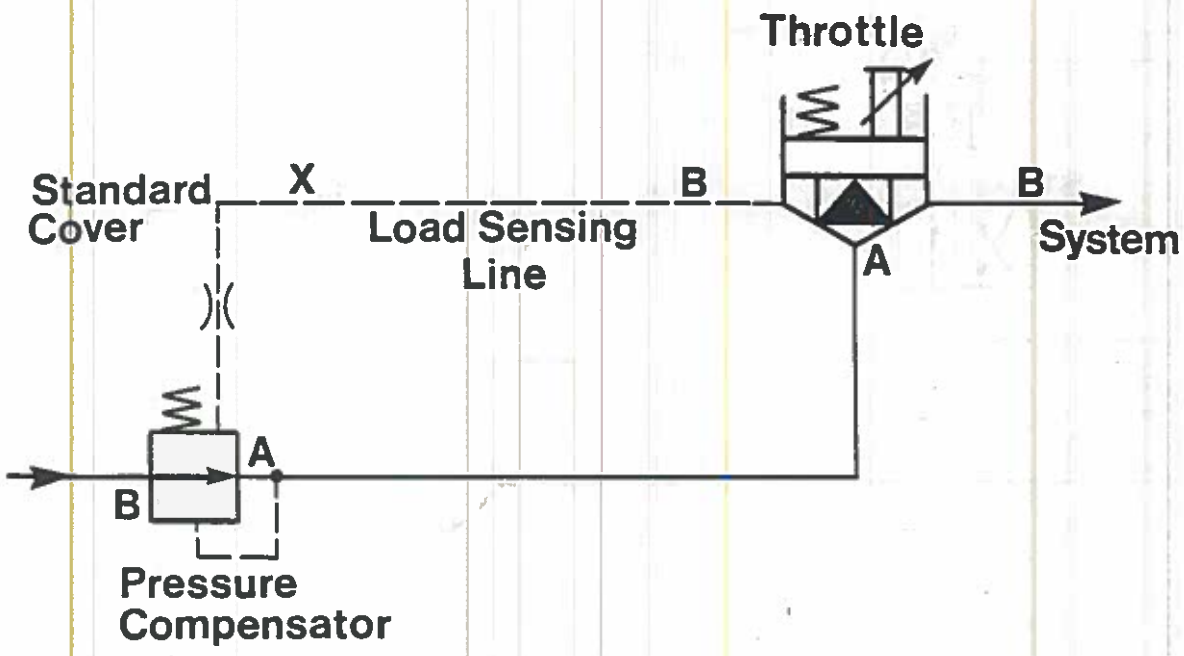


FIGURE NO. 41 RESTRICTOR TYPE FLOW CONTROL

When a reducing valve insert with standard cover is installed in series with the 1:2 metering cartridge with stroke adjustment cover to act as a compensator, the pressure difference across the metering poppet (throttle) is held constant. (The pressure difference is determined by the spring force in the reducing valve). The flow rate through the throttle will therefore be held constant. The flow rate through the throttle may be changed by varying the stroke adjusting screw position.

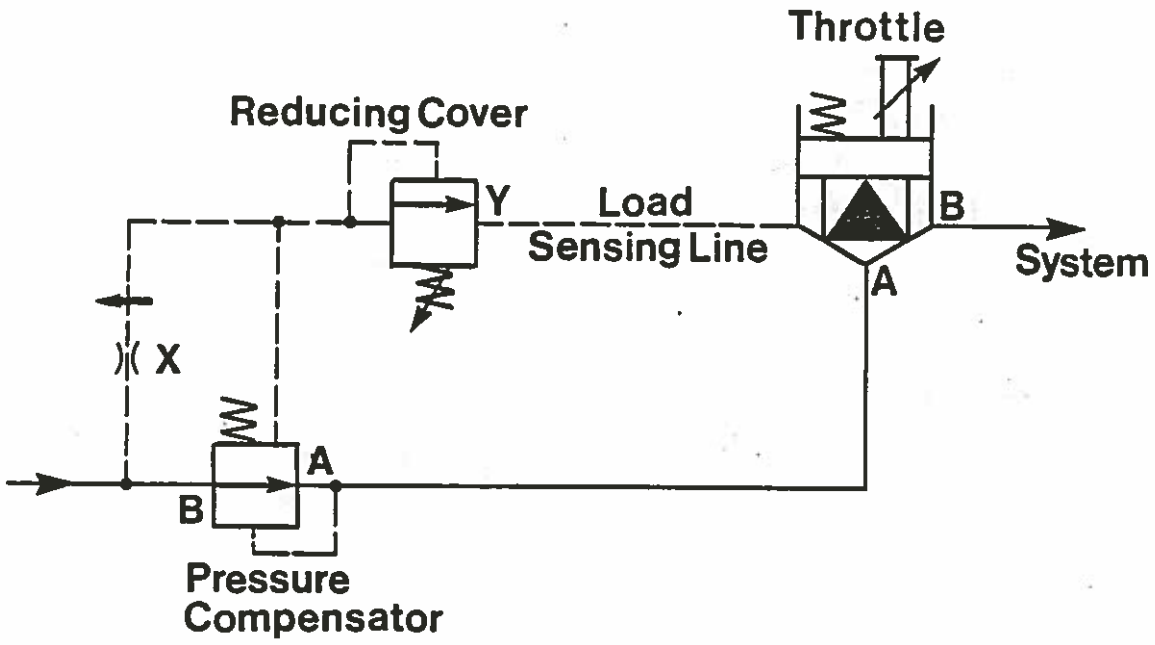


FIGURE NO. 42

The pressure difference across the throttle of the restrictor type flow control may be varied by replacing the standard cover used with the reducing insert, with a reducing valve cover. The drain port (Y) of the reducing cover must be connected downstream from the throttle in order to sense the load pressure. The pressure drop across the throttle is now determined by the setting of the reducing cover pilot stage plus the spring value of the reducing insert. The flow rate through the valve may now be adjusted by varying the reducing cover spring setting and/or the setting of the stroke limiter. Increasing the reducing cover spring force provides higher flow capability of the throttle. The restrictor type flow control may be used in meter-in, meter-out or bleed-off circuits.

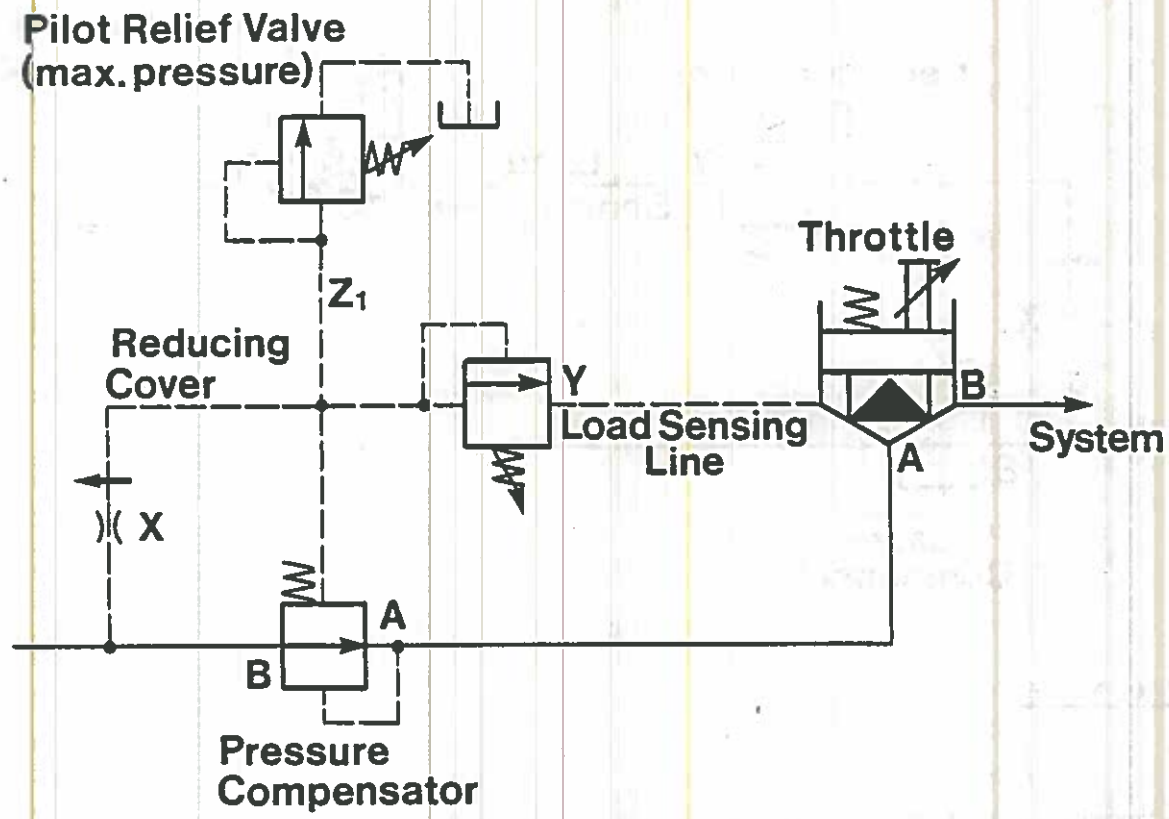


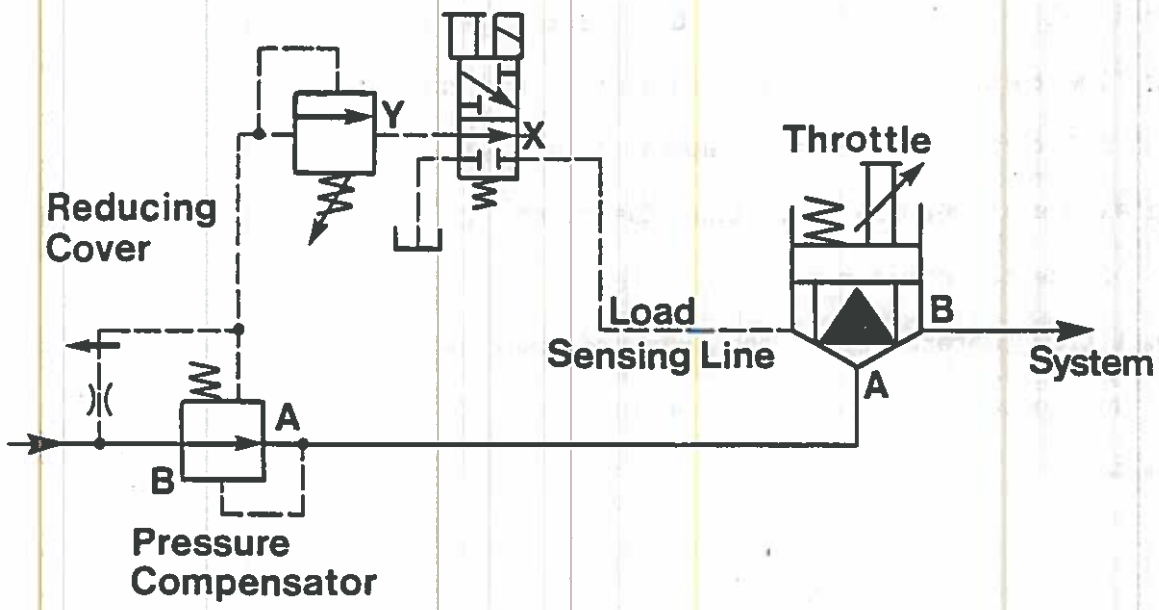
FIGURE NO. 43 FLOW CONTROL AND REDUCING VALVE

The cartridge restrictor type flow control may also be used to limit the maximum pressure downstream from the throttle by the addition of a pilot relief valve. The flow control operates the same as in figure 40, except that the relief valve now limits the maximum pressure in the spring chamber of the reducing insert, thereby allowing the valve to operate as both a flow control and a pressure reducing valve when applied as a meter-in valve.

FIGURE NO. 43 (cont'd)

Remember that unlike the standard resistor flow control valve, the cartridge version is also used as one of the flow paths of a directional valve. When the throttle cartridge is piloted closed to block flow to the actuator, it is possible for the actuator to creep due to pilot flow in the load sensing line. Across the throttle there exists a pressure difference due to the higher pressure at the inlet of the compensator protion of the valve. There will still be a small flow (determined by the pressure compensated flow control in the reducing cover) across the reducing cover pilot stage and into the actuator.

FIGURE NO. 44



To prevent this unwanted flow, a spring offset directional valve may be installed in the load sensing line between the reducing cover and the outlet port of the throttle cartridge valve as shown in this figure.

The spool is hydraulically balanced by means of a drilled passage which connects the A port area to the annulus area on the top of the spool. A spring biases the spool to the closed position and so the solenoid force only has to overcome the spring force.

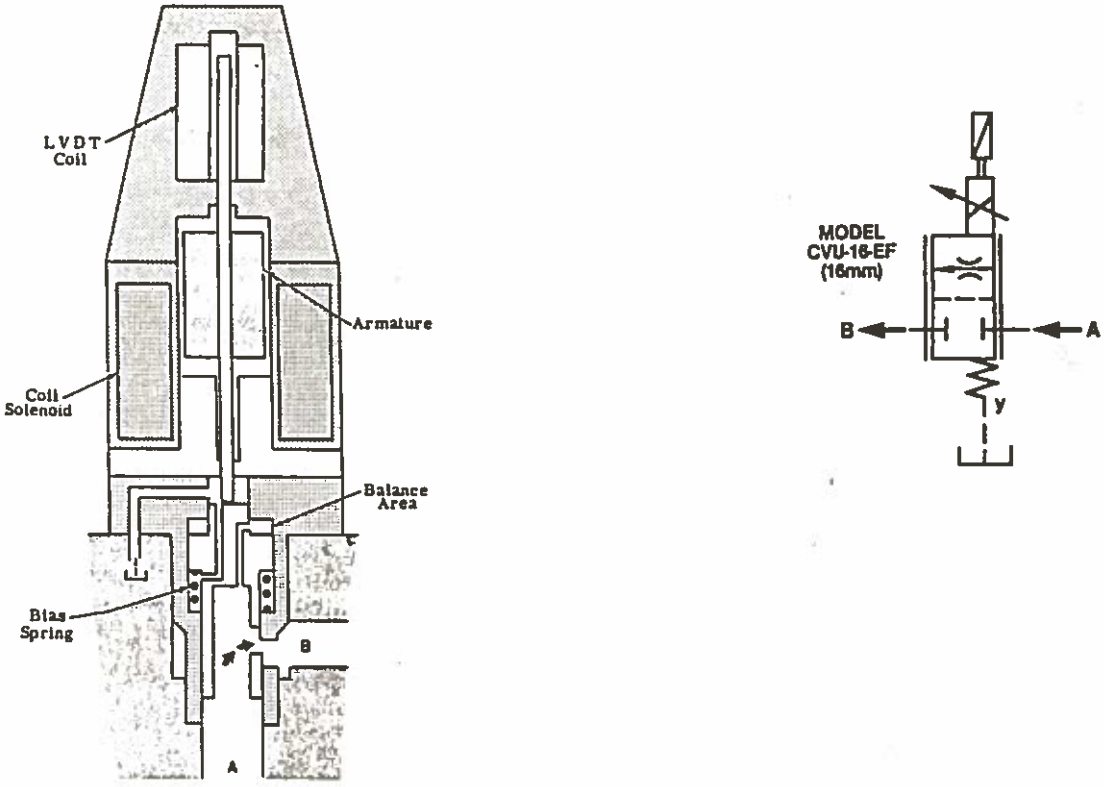


FIGURE 45

The solenoid is used with a closed loop electronic control whereby an input signal continuously opens the valve until the reguired amount of opening is achieved, when the LVDT feedback signal coincides with the input signal. The valve opening is therefore proportional to the solenoid input signal. In its basic form, the valve is non-pressure compensated, but may be incorporated with a hydrostat or flow sensor as shown in the flow control circuits in this section by replacement of the throttle stroke adjust cover and insert.

Larger cartridge sizes use a two stage arrangement as shown in figure 46. In this case the proportional solenoid acts directly on a spring loaded pilot spool. A pilot flow is taken from the inlet (A) port of the valve and is bled to tank via the port that connects to the top of the main poppet.

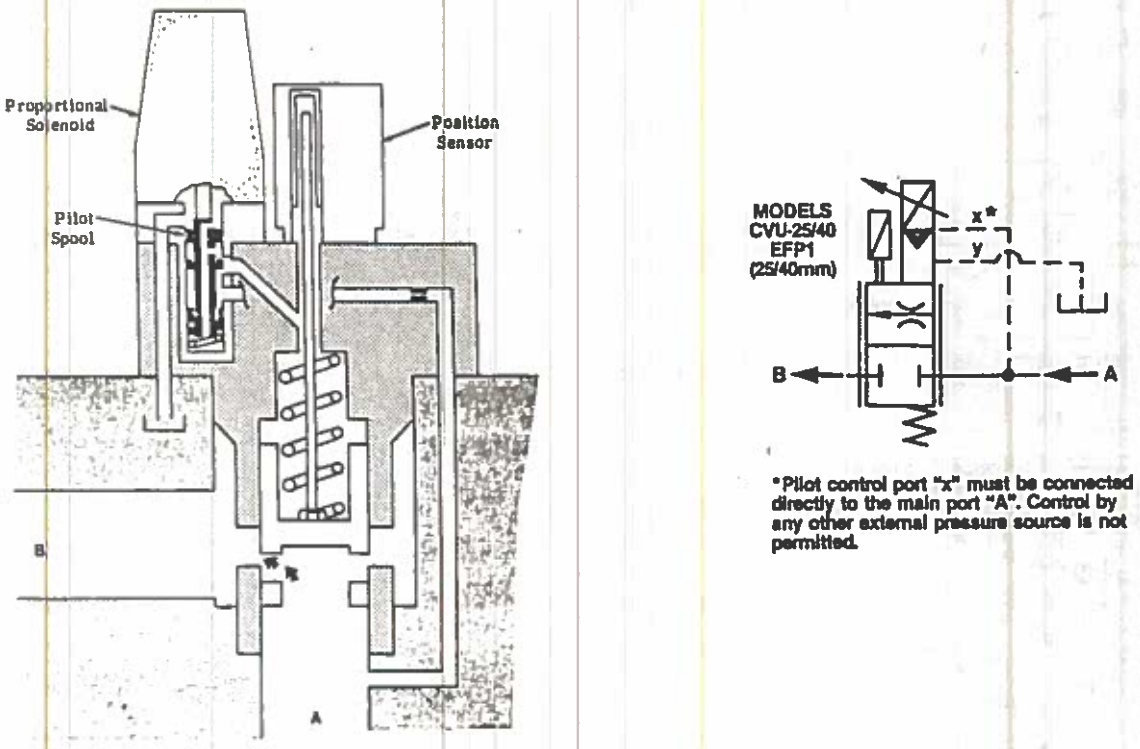


FIGURE 46

With zero signal to the solenoid, the spring pushes the pilot spool to the fully up position. This blocks the pilot bleed flow so full inlet port pressure is applied to the top of the main poppet. With the same pressure top and bottom of the main poppet, its spring pushes it to the fully closed position. As a signal is applied to the solenoid, the pilot spool moves down. This opens up a bleed path for the pilot flow and reduces the pressure

on the top of the main poppet. This pressure drop causes the poppet to lift, opening the main flow path through the valve until the feedback signal from the position sensor coincides with the input signal to the solenoid. The valve then reaches a steady state position at an opening determined by the input signal.

The pilot supply for the valve must be taken directly from the A port, and be a minimum pressure of 10 bar.

As with the direct acting version, the valve is non-pressure compensated and must be used in conjunction with either a hydrostat or flow sensor if pressure compensation is required.

ELECTRONIC CONTROLLER FOR THROTTLE VALVES

The electronic controller is a unit designed specifically for the control of a proportional solenoid valve, with electrical position feedback.

Connection Diagram

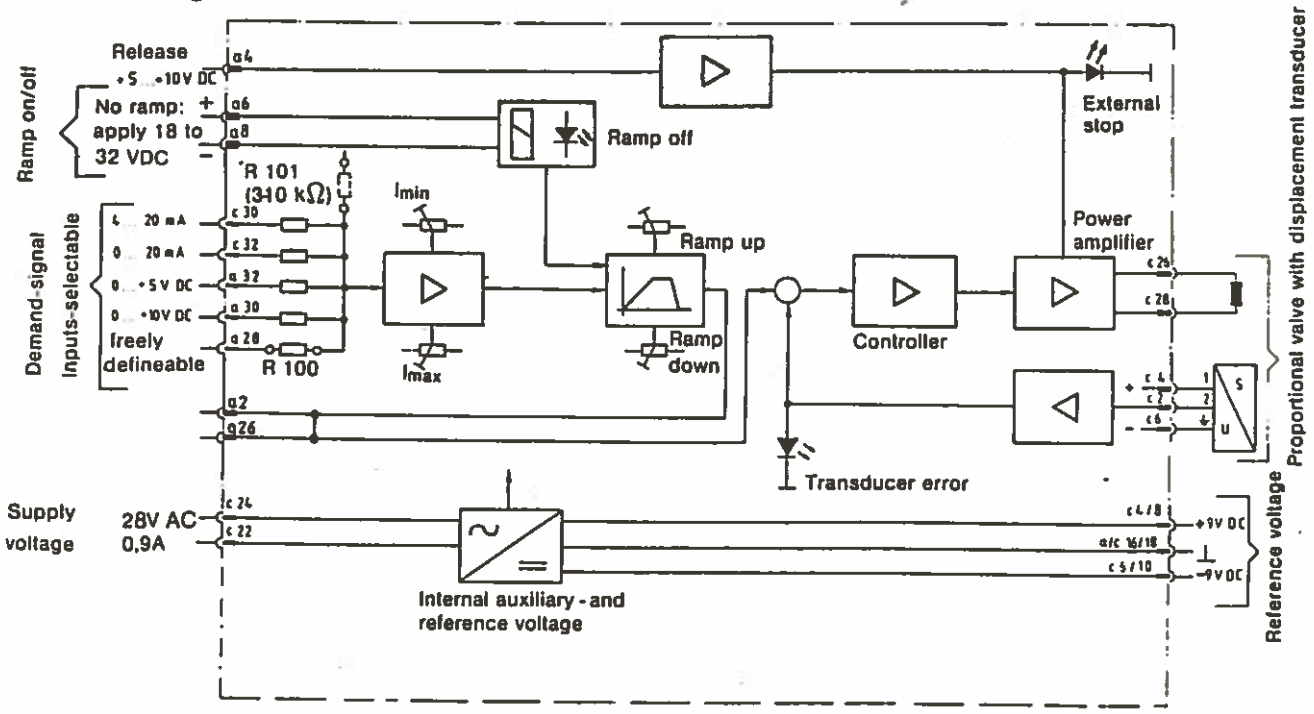


FIGURE 47

The command signal can be provided by an external potentiometer, an external voltage source, or by switching internal relays to select any combination of four internal potentiometer settings. With the internal pots set at 1, 2, 4, and 8 volts, up to a total of 16 discrete (binary code) voltage levels can be selected.
Adjustable internal ramp potentiometers provide independent control of acceleration and deceleration rates within the range of 50 to 350 ms.
Minimum response of the stroke sensor and the start-up point of the output signal can be selected by adjusting the "ZERO BALANCE"potentiometer. The upper limit of input current can be adjusted via the "MAX" potentiometer.

PRESSURE CONTROL CIRCUITS

The circuits in this section are examples of pressure control systems. They show the basic control for instruction purpose only. Changes in circuitry may be required to satisfy all requirements of an application.

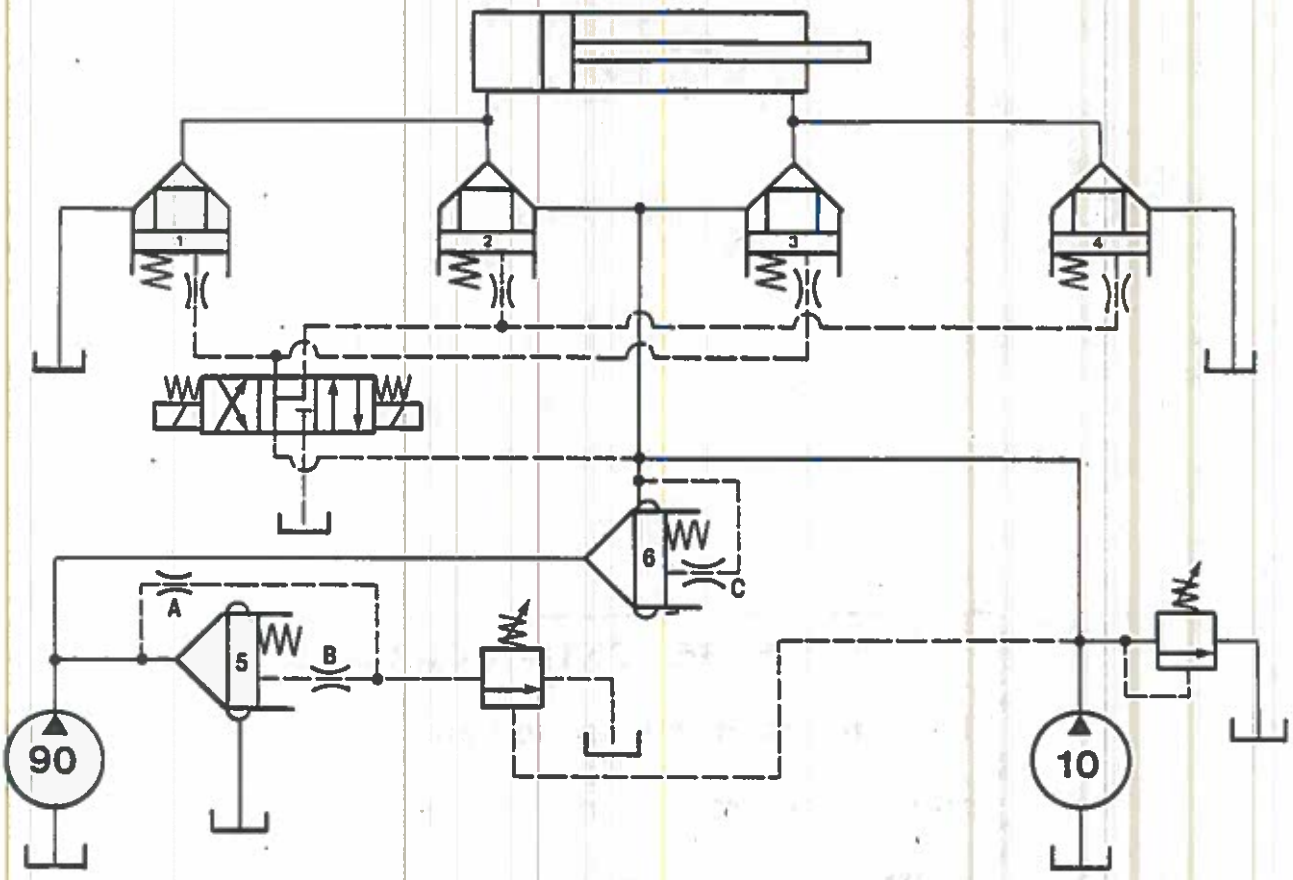


FIGURE NO. 49 UNLOADING

This high/low circuit shows a typical unloading valve application. A 1:1 cartridge with a 2 bar spring and a standard cover is used as an unloading valve (Valve #5).A small unloading valve, is used to control the operation of the cartridge unloading valve. The cylinder is controlled by a typical 4-way cartridge directional valve arrangement. Another 1:1 cartridge insert with a 2 bar spring is employed as a check valve (Valve #6) to prevent the output of the small pump from dumping through the unloading valve.

During the high flow, low pressure phase of operation, the pressures at the A port and on area AP of the unloading valve will be equal and the spring will hold the poppet closed. The large volume pump

FIGURE NO. 49 (cont'd)

delivery is directed through the check valve (#6) to join the smaller volume pump and extend the cylinder. When the cylinder goes into the work cycle where high pressure but low flow is required, the pressure rise at the small volume pump outlet is sensed in the pilot port of the unloading valve. The unloading valve will be set to open approximately 150 PSI above the circuit's low pressure requirement. The pressure during the low flow, high pressure phase of operation must be high enough to hold the unloading valve pilot wide open. This in turn will drain the spring chamber of valve #5 to tank. With the spring chamber drained to tank the large volume pump will work just hard enough to overcome valve #5's spring (2 bar). The orifices at B and C are used to control the opening and closing speeds of their poppets, thereby reducing the possibility of hydraulic shock.

Note that the unloading valve used here is limited to a maximum of 3000 PSI. This limits the maximum operating pressure of the cartridge valve to 3000PSI. A pilot valve which would permit operation of the unloading valve at pressures higher than 3000 PSI would be a single solenoid, spring-offset directional valve. The solenoid would be controlled by a pressure switch sensing the pressure at the outlet of the small volume pump. The pressure switch would be set at a pressure slightly above the pressure requirement of the high volume phase of operation. In this manner the maximum, 5000 PSI, pressure capability of the cartridge valves could be utilized.

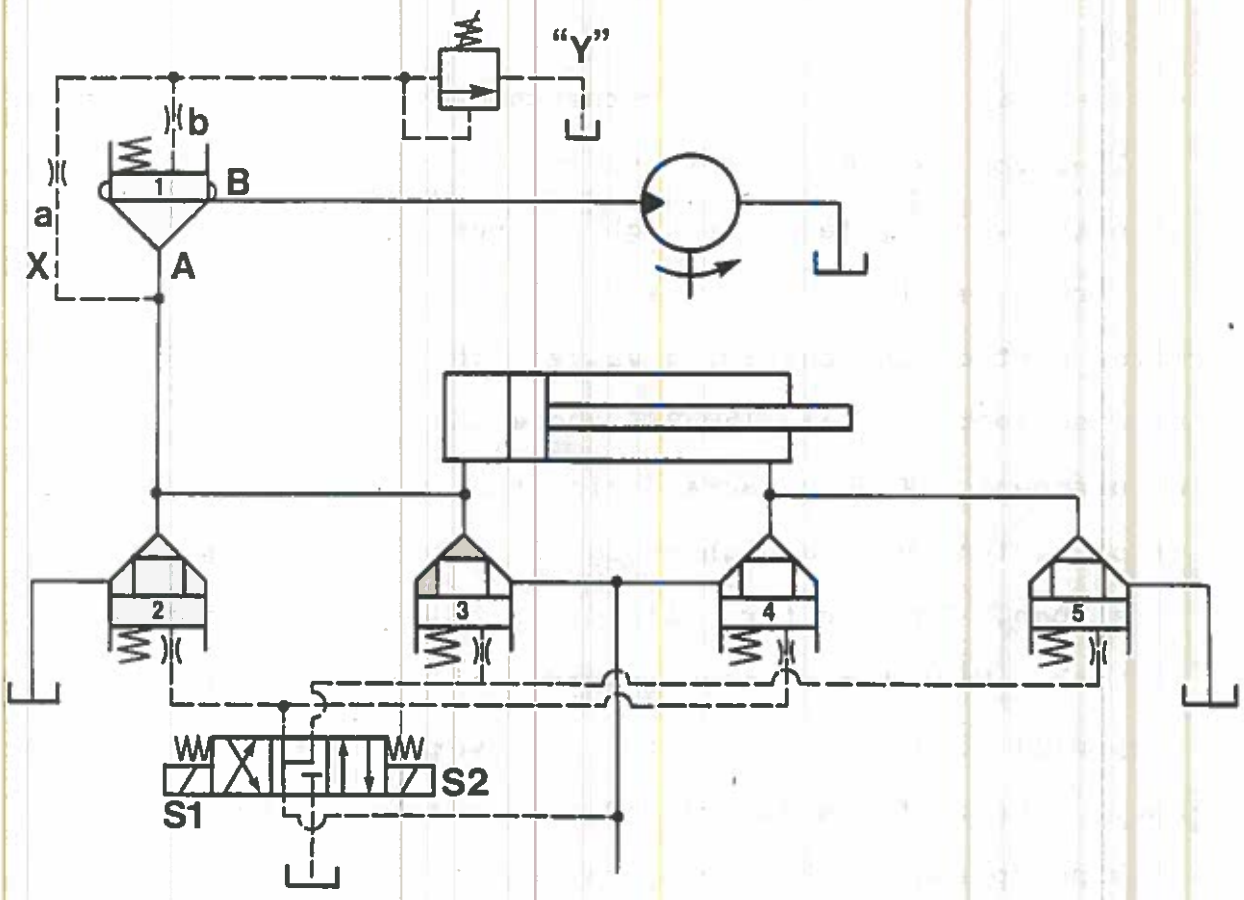


FIGURE 50

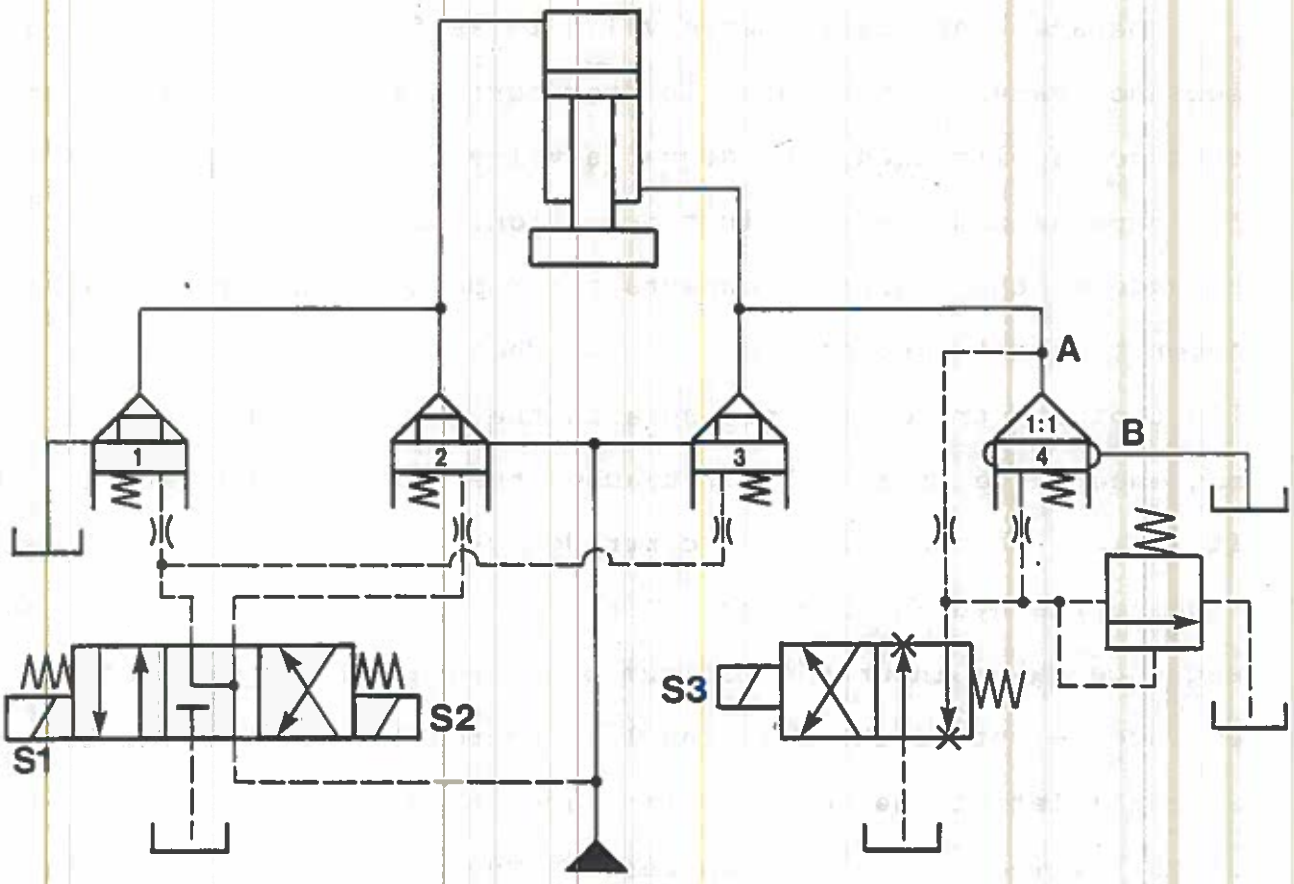
SEQUENCE

The sequence of events in the circuit shown are that the cylinder extends before the motor turns. The motor is unidirectional and must be stopped while the cylinder is retracting. The 4-way valve controlling the cylinder is a standard 4-way cartridge valve arrangement. The sequence valve consists of a 1:1 insert with a 2 bar spring and a relief valve cover which is externally drained thru the Y port.

FIGURE NO. 50 (cont'd)

The operation of the sequence valve is as follows: Flow through the sequence valve to the motor is from port A to port B. As in any sequence application, the sequence valve is set higher than the pressure needed for the first operation. In this circuit a drilled passage in the manifold connects the X port of the relief valve cover to the A port of the insert. When the cylinder reaches the limit of its travel the pressure in the spring chamber of the sequence valve rises till it reaches the relief valve setting. When it exceeds that setting the cartridge valve poppet opens, allowing flow to the hydraulic motor. During this phase of the operation the sequence valve insures a minimum pressure at the cap end of the cylinder - but if the rotating load increases, causing the pressure at the inlet of the motor to increase, then pressure at the cap end of the cylinder will also increase. The pressure at both actuators will be limited by the main system relief valve (not shown).

The orifice at 'b' is used to control the opening and closing rate of the poppet to limit system shock.



COUNTERBALANCE

Counterbalance valves are pressure control valves. They are included in hydraulic systems in which back pressure is required to prevent a load from falling. A typical counterbalance circuit is shown here. This circuit controls the main cylinder of a forming press. This type of press has a very heavy platten fastened to the piston rod of the down acting cylinder. To prevent the platten from falling freely during the "close" portion of the press cycle a counterbalance valve is included in the circuit.

FIGURE NO. 51 (cont'd)

Valve #4 has a 1:1 area ratio, a 2-bar spring, a relief valve cover and is controlled by a 2-position pilot valve. As shown in the drawing the AP area of valve #4 is connected to its A port. It is also connected to the pressure port of a pilot relief valve and to one of the cylinder ports of a spring offset solenoid valve.

The pilot relief valve that is connected to #4 should be adjusted so that it will open 50 to 100 PSI above the pressure in the rod end of the cylinder. With solenoids S1, S2, and S3 de-energized, all four of the cartridge valves will be closed; numbers 1, 2, and 3 by pilot pressure. Number 4 will be closed because its 1:1 poppet has the same pressure on both sides. Its 2-bar spring holds it closed.

To raise the platten energize solenoid S1, this opens the AP areas of #1 and #3 to tank. Oil from the pump will open #3 and raise the platten. Oil exiting the cap end of the cylinder will push open #1 and go on to tank. Number 2 will stay closed because pilot pressure from the pump is still acting on it. Number 4 will stay closed because the pressure on its A and AP area, the two areas are equal and the 2-bar poppet spring has enough force to hold the poppet on its seat.

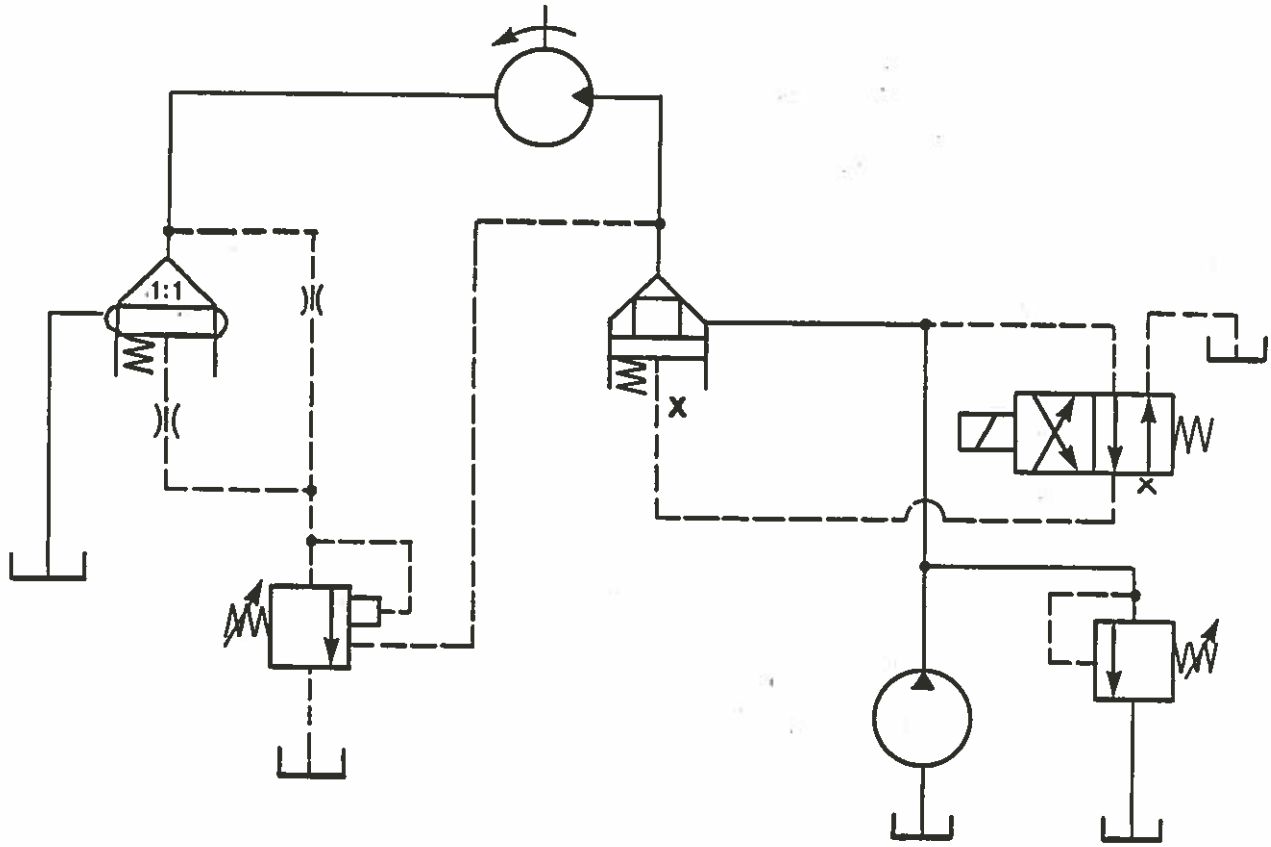
To lower the platten energize only solenoid S2. This opens the AP area of #2 to tank and holds pilot pressure on both #1 and #3. Oil from the pump acts on the B area of #2, lifts the poppet off its

FIGURE NO. 51 (cont'd)

seat and flows into the cap end of the cylinder. However, the platten will not lower because #4 is still closed and it will stay closed until either solenoid S3 is energized or the pilot relief valve opens. The weight of the platten plus the force of the oil being pumped into the cap end will raise the pressure in the rod end until the pilot relief valve opens. Ths oil passing through the pilot relief valve must also squeeze through the orifice between the A and AP portions of #4. This means that the pressure on the A side of the orifice will be higher than that on the AP side. As the flow rate through the relief valve increases the pressure differential across the orifice increases until it becomes large enough (about 2 bar) to overcome the spring holding the poppet closed. Oil can now flow from the A to B ports of #4 and the platten will lower but not at a rate faster than the pump dictates. As long as solenoid S3 is not energized, the relief valve will maintain enough pressure on the rod end of the cylinder to prevent the platten from falling freely.

As soon as the platten reaches the work piece it is necessary to remove the back pressure on the rod end of the cylinder in order to exert full force during the pressing operation. This is done by energizing solenoid S3. This opens the AP area of valve #4 to tank. The only pressure needed to open #4 will now be that required to overcome the poppet spring about 2 bar.

FIGURE NO. 52



BRAKE CONTROL CIRCUIT

The cartridge insert used in the brake valve application employs a 1:1 ratio metering poppet, a standard cover, and a P type pilot pressure control valve which contains a external pilot control. A 1:2 insert is used to start and stop the motor by permitting or blocking fluid flow to the motor. This cartridge is controlled by the solenoid controlled directional valve. To start the motor, energize the directional valve, this drains the cartridge spring chamber to tank permitting pump flow to the motor. The pressure to accelerate the motor is communicated to the pilot valve shifting its spool and thereby draining the spring chamber of the main stage of the brake system.

FIGURE NO. 52 (cont'd)

The main stage poppet is opened by the discharge flow from the motor. When the motor is up to full speed the inlet pressure of the motor will decrease. However, it is still high enough to keep the pilot valve shifted and the metering poppet spring chamber drained to tank. The motor then will be driven at the speed determined by the pump delivery.

When the solenoid is de-energized to stop the motor, the cartridge valve is piloted closed by the pump pressure in its spring chamber. The pressure at the motor inlet will drop to Ø bar, allowing the pilot spool to move toward its spring offset position. The inertia of the motor load now drives the motor as though it were a pump, causing pressure at its outlet to increase. The pressure increase at the spring chamber of the metering poppet is limited by the relief valve cover which in turn will determine the motor outlet pressure. This pressure at the motor discharge port will apply a braking force to the motor. The deceleration rate (braking time) can be adjusted at the pilot valve. A check valve should be located between the motor inlet and the tank to prevent the motor from cavitating while decelerating.

Printed in U.S.A.

CARTRIDGE VALVES

MODEL SERIES CVI/CVC

FOR DIRECTIONAL, CHECK AND FLOW RESTRICTED FUNCTIONS

STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

GENERAL DATA

Cartridge valves for directional and check functions are essentially hydraulically piloted check valves.

Control options include single or multiple pilot arrangements, main flow restrictors and solenoid operated pilot directional control. Grouping cartridge assemblies (selected individually according to flow requirements) for control by one or more common pilot valves can provide directional, check and/or flow restrictor functions for flow rates up to 2800 l/min per cartridge.

Typical single cartridge arrangements are symbolized on pages 2-3, and your Vickers representative can illustrate various grouped arrangements.

Each cartridge insert fits into a DIN 24342 recess and consists of a sleeve, a seated spool and a closing spring. It is retained by a control cover that can vary according to the application.

Apart from the basic spools illustrated on this page, others provide flow restrictions between A and B and a restricted pilot flow between port A and spring chamber AP. Spools can be combined with different springs to provide three different cracking pressures. Standard combinations are shown in the "Cartridge Valve Inserts" table on page 6.

RATINGS

Nominal Sizes ..... 16mm, 25mm, 40mm, 50mm and 63mm
Maximum Operating Pressure ..... 350 Bar
Maximum Flow Rate ($\Delta p = 5$ Bar):

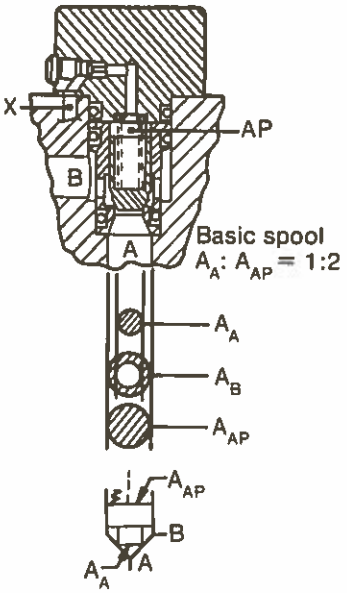
16mm	200 l/min (53 GPM)
25mm	450 l/min (119 GPM)
40mm	1100 l/min (291 GPM)
50mm	1700 l/min (449 GPM)
63mm	2800 l/min (740 GPM)

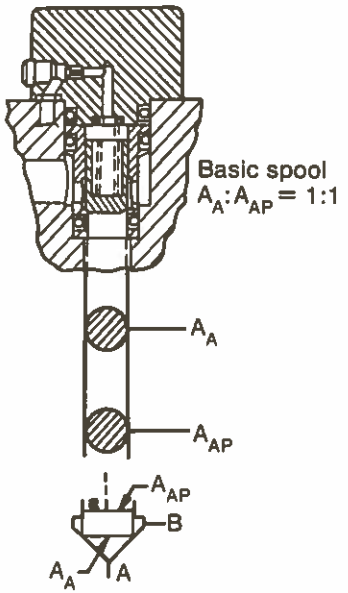
Control Covers

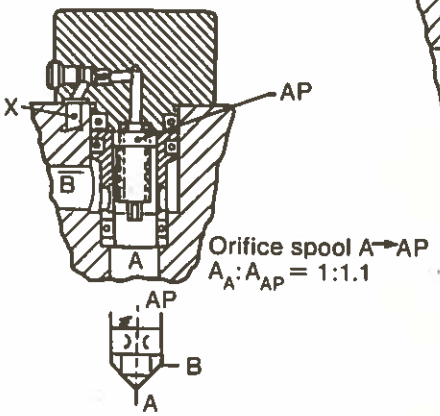
The control cover retains the cartridge and contains pilot passages and any necessary integral pilot valve or manual adjustment for limiting the spool lift. Provision is also made for the fitting of one or more orifices to optimize cartridge response in relation to that of the complete hydraulic system. Similar covers have, in addition, an NFPA-D01 or D02 mounting surface for a suitable pilot directional valve. Pilot functions can be extended by adding one or more pilot valve modules between the pilot valve and the cover.

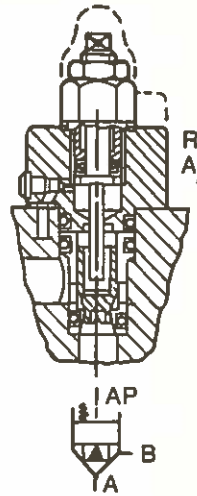
Spool Type, Area Ratio, Functional Symbols

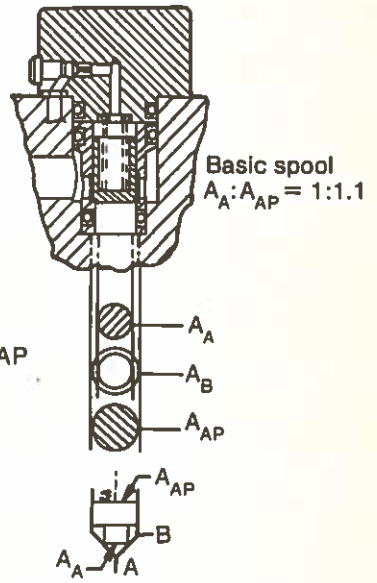
A = Main port
B = Main port
X = External pilot line
AP = Spring chamber
A_A = Effective area of port A
A_B = Effective area of port B
A_{AP} = Effective area of port AP











FUNCTIONAL SYMBOLS

Standard Orifices

Valve	Orifice Size
16mm	1.0mm
25mm	1.2mm
40mm	1.4mm
50mm	1.6mm
63mm	1.8mm

Optional Orifices

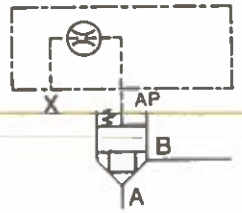
Orifices may also be placed in the optional locations indicated by means of a threaded plug.

Orifice kits are available to allow fine tuning on the application. (For sizes, see chart below.)

2-Way/2-Position Function

Basic cover; basic spool.

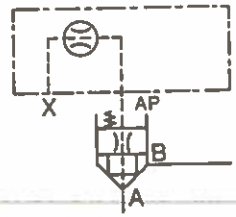
Pilot closed externally from port X. Alternatively, connecting ports X and B externally provides a check valve function.



2-Way/2-Position Function With Internal Pilot

Basic cover; orifice spool.

Pilot flow from A to X permits main flow through to B. When X is blocked, the valve shuts, but if pressure at B is higher than at A, flow may occur from B to A.

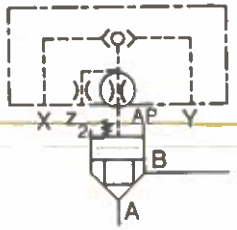


Pilot Shuttle Control

Cover with pilot shuttle valve; basic spool.

The pilot close pressure is the higher of those in the X and Y lines.

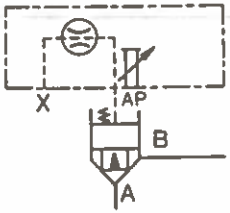
Note:
Available in 16mm, 25mm, and 40mm valves only.



Adjustable Flow Restrictor

Cover with stroke limiter; restrictor spool.

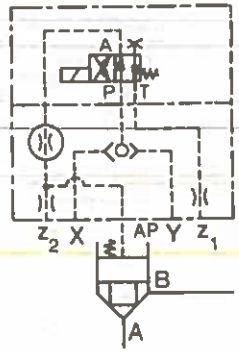
Adjustable limiting of spool lift restricts main flow in both directions.



Single Solenoid Control—25mm and 40mm Valves

Cover with pilot valve mounting surface; basic spool; single solenoid, spring offset pilot valve.

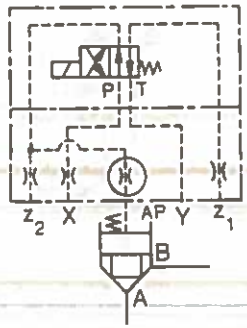
Used with additional cartridges, piloted from z_1 and z_2 to reproduce conventional four-port directional valve functions.



Single Solenoid Control—50mm and 63mm Valves

Cover with pilot valve mounting surface; basic spool; single solenoid, spring offset pilot valve.

Used with additional cartridges, piloted from z_1 and z_2 to reproduce conventional four-port directional valve functions.



Orifice Kits

Consisting of Sizes (Orifice Diameter in mm)	16mm Valve Size Thread Size .1900-32 UNF Orifice Kit No. 926281	25/40mm Valve Size Thread Size .2500-28 UNF Orifice Kit No. 926282	50/63mm Valve Size Thread Size .4375-20 UNF Orifice Kit No. 926283
0.5	635132	635149	—
0.6	635133	635150	—
0.7	635134	635151	—
0.8	635135	635152	635173
0.9	—	635153	—
1.0	635136	635154	635174
1.1	635137	635155	—
1.2	635138	635156	635175
1.3	635139	635157	—
1.4	635140	635158	—
1.5	635141	635159	635176
1.6	—	—	635177
1.7	—	635160	—
1.8	—	—	635178
2.0	—	—	635179
2.3	635142	—	—
2.5	—	635161	—
3.0	—	—	635180
5.4	—	—	675958
Plug (solid)	35633	812	675169

Typical constructions are shown on pages 8, 9, 10 and 11.

Note:
Available in 16mm, 25mm, and 40mm valves only.

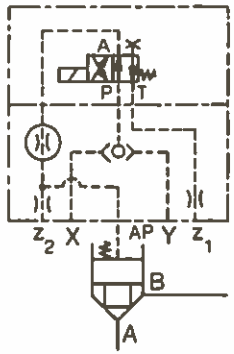
Solenoid Controlled Pilot Shuttle Function — Type 1

Cover with pilot shuttle valve; basic spool; solenoid operated 4/2 pilot directional valve.

Pilot port z_2 downstream of solenoid pilot valve.

With the solenoid valve de-energized the cartridge is shut by the higher of the pressures of X and Y.

Note:
Available in 25mm and 40mm valves only.



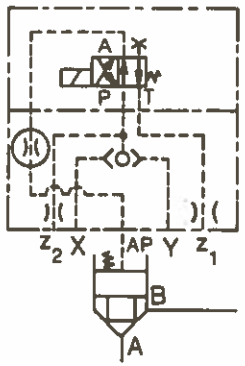
Solenoid Controlled Pilot Shuttle Function — Type 2

Cover with pilot shuttle valve; basic spool; solenoid operated 4/2 pilot directional valve.

Pilot port z_2 upstream of solenoid pilot valve.

With the solenoid valve de-energized, the cartridge is shut by the higher of the pressures of X and Y.

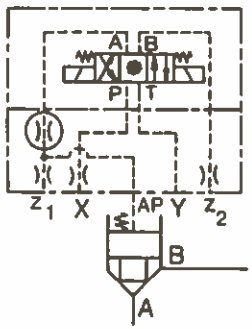
Note:
Available in 25mm and 40mm valves only.



Dual Solenoid Control — 25mm and 40mm Valves

Cover with pilot valve mounting surface; basic spool; double solenoid, spring centered pilot valve.

Used with additional cartridges, piloted from z_1 and z_2 to reproduce conventional four-port directional valve functions.

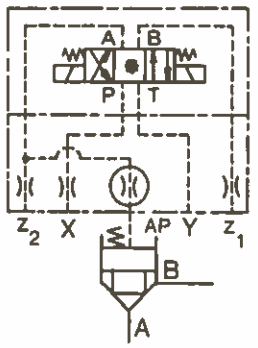


Dual Solenoid Control — 50mm and 63mm Valves

Cover with pilot valve mounting surface; basic spool; double solenoid, spring centered pilot valve.

Used with additional cartridges, piloted from z_1 and z_2 to reproduce conventional four-port directional valve function.

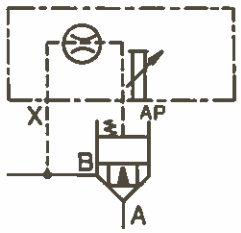
Note
Z_1 and Z_2 port orientation is reversed.



Check and Flow Restrictor Functions

Cover with stroke limiter; restrictor spool.

Spool lift limiter restricts flow from A to B. Check function prevents flow from B to A.



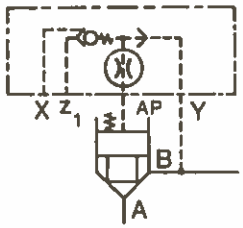
Pilot Operated Check Function (Pilot Open)

Cover with external pilot connection X; basic spool.

Pilot pressure at X permits flow from B to A. Flow from A to B is independent of pilot pressure.

Note:
Available in 16mm, 25mm, and 40mm valves only.

Port "B" is connected to the system load. The pilot pressure of "X" must be at least 30 percent of the load pressure, the latter including any intensification that may occur, e.g. when controlling double-acting cylinders.



OPERATING DATA

Unless otherwise stated, performances are based on mineral oil at 25 cSt and at 50°C (120°F).

Pressure Limits Ports A and B

Minimum 0.3 to 5 bar, dependent on the spool/spring combination. See "Cartridge Valve Inserts" table on page 6.

Maximum 350 bar for all cartridges except where the 50mm and 63mm sizes are used with DG4S4-01 pilot valves, for which the limit is 210 bar.

Pilot Ports

Maximum pressure limits for ports A and B above are dependent on the limits of any associated pilot valves or modules.

Control Data Pilot Operated Functions

Internally piloted arrangements operate automatically under the influence of the pressure difference between the main ports.

Externally piloted arrangements require the application of pilot flows and pressures appropriate to the application and within the limits of any associated pilot valves and modules, whichever have the lower limits.

See note on page 8 concerning pilot operated check functions.

Flow Ratings

Size	Nominal At Δp = 1 Bar l/min (GPM)	Max. At Δp = 5 Bar l/min (GPM)
16mm	90 (24)	200 (53)
25mm	210 (55)	450 (119)
40mm	650 (172)	1100 (291)
50mm	900 (238)	1700 (449)
63mm	1250 (330)	2800 (740)

Solenoid Operated, Hydraulically Piloted Arrangements

For details of the DG4V3 and DG4S4 series solenoid controlled valves, see Vickers Installation drawings 517351 (DG4V3) and 517401 (DG4S4).

Response Times

Arranged to suit the application bearing in mind the possibilities for grouping cartridges under one pilot control and the facility for "tuning" the relative response of one cartridge to another.

HYDRAULIC FLUIDS

All valves can be used with antiwear hydraulic oils, water-in-oil emulsions, water glycols and certain low viscosity fluids.

Note:

Add prefix "F3" to model designations of DG4S4 electrically operated pilot valves and order cartridge and module assemblies by special kit numbers obtainable from Vickers when phosphate ester (not alkyl-based) or chlorinated hydrocarbons are to be used.

The extreme viscosity range is from 500 to 5 cSt but the recommended range is from 54 to 5 cSt. Consult Vickers if the minimum viscosity will be less than 13 cSt.

For further information about fluids, see Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400).

TEMPERATURE LIMITS

Ambient

Minimum .....−10°C(14°F)
Maximum .....+70°C(160°F)

Fluid Temperature

Mineral Oil
Minimum .....−10°C(14°F)
Maximum* .....+80°C(180°F)

Water Containing
Minimum .....+10C°(50°F)
Maximum* .....+54°C(130°F)

*To obtain optimum service life from both fluid and hydraulic system, 65°C(150°F) is normally the maximum temperature except for water-containing fluids.

For synthetic fluids, consult manufacturer or Vickers representative where limits are outside those for mineral oil. Whatever the actual temperature range, ensure that viscosities stay within the limits specified in the "Hydraulic Fluids" section.

FILTRATION REQUIREMENTS

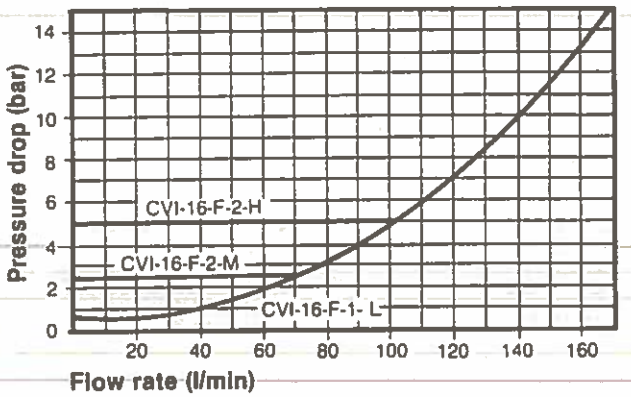
Adequate fluid filtration for protection from environmental contaminant ingression and generated contaminants must be provided to ensure reliable system performance and long service life.

For cartridge valves, 10-micrometer elements can be used to maintain most systems at an ISO cleanliness code of 18/13. This protection can be provided by Vickers OFP pressure filters and OFR or OFRS return line filters.

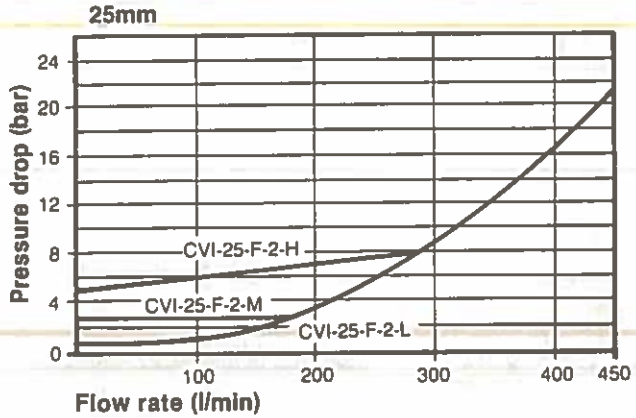
Refer to Section "P"-"Filters" and Section "S"-"Technical Information" of Vickers Catalog 400, or contact your Vickers representative for further filtration advice.

Pressure Drop/Flow Data CVI-**-F Inserts

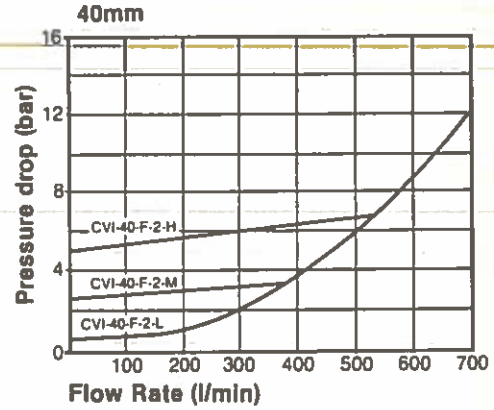
16mm



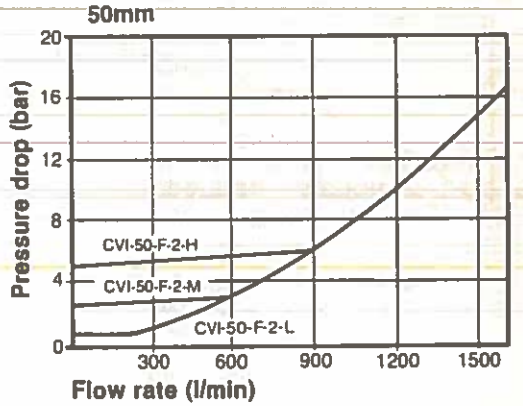
25mm



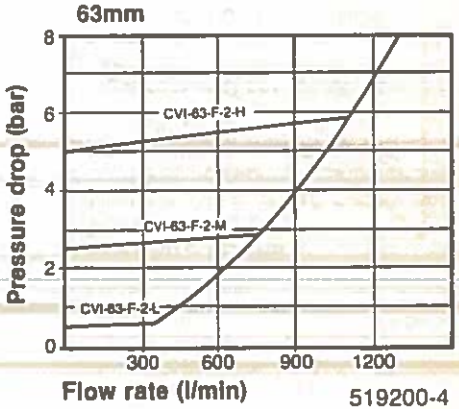
40mm



50mm



63mm

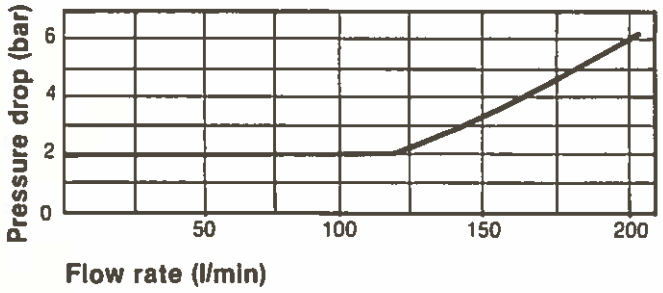


519200-4

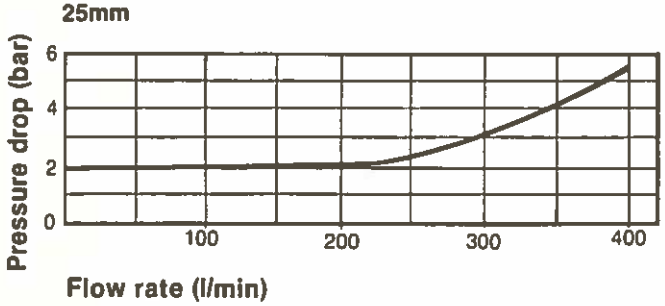
Pressure Drop/Flow Data

CVI-**-D10 Inserts

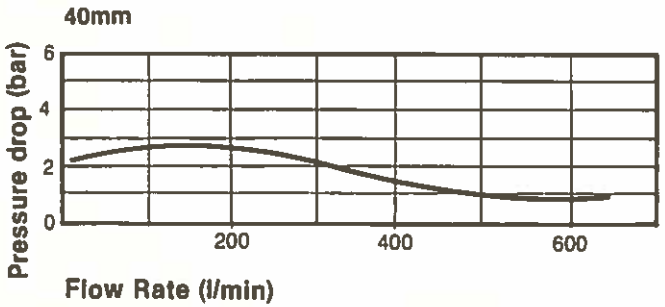
16mm



25mm

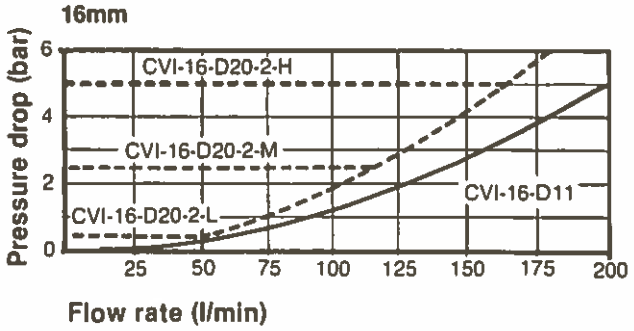


40mm

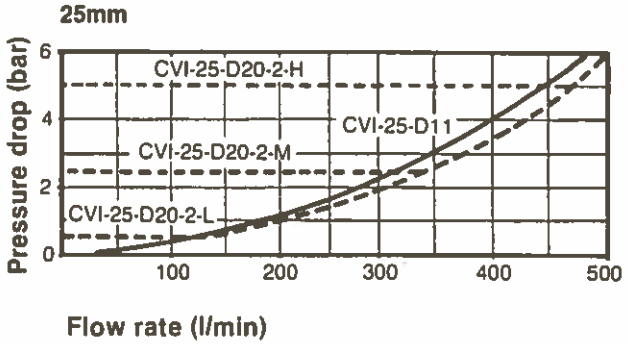


CVI-**-D11 and D20 Inserts

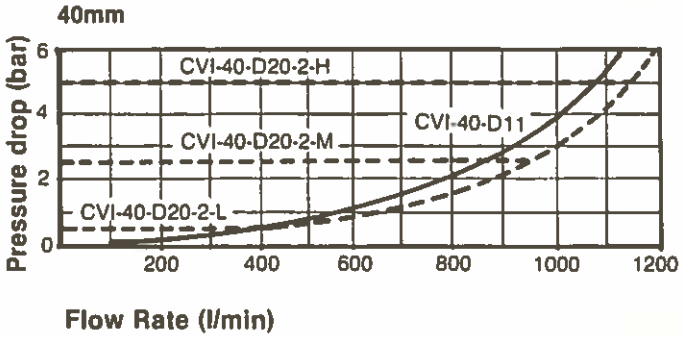
16mm



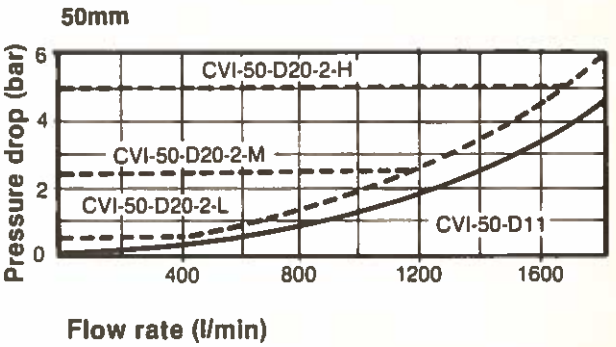
25mm



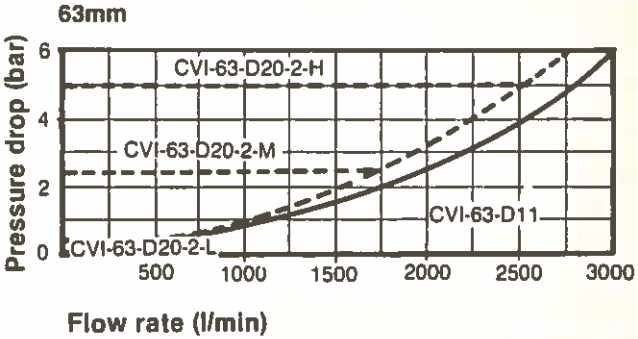
40mm



50mm



63mm



ASSEMBLY NUMBERS
Control Cover

Ref.	Cover Type	Symbol	Assembly Numbers				
			16mm	25mm	40mm	50mm	63mm
A	Basic CVC-••-N-S2-10		580006	580045	580085	589120	589143
B	Stroke limiter with micrometer knob CVC-••-A-S2-M-10		580007	580046	—	—	—
C	Stroke limiter with micrometer knob and key-lock CVC-••-A-S2-K-10		580008	580047	—	—	—
D	Stroke limiter with screw adjustment CVC-••-A-S2-W-10		—	—	580086	589121	589144
E	Stroke limiter with screw adjustment and cap CVC-••-A-S2-W-10		580009	580053	—	—	—
F	Pilot operated check function CVC-••-PC-S2-10		580011	580052	580087	—	—
G	NFPA-D01 mounting surface CVC-••-D1-S2-10		—	580048	580088	—	—
H	NFPA-D02 mounting surface CVC-••D2-S2-10		—	—	—	589122	589145
J	Pilot shuttle valve CVC-••-W-S2-10		580010	580049	580089	—	—
K	Pilot shuttle with NFPA-D01 mounting surface, type 1 CVC-••-W11-S2-10		—	580050	580090	—	—
L	Pilot shuttle with NFPA-D01 mounting surface, type 2 CVC-••-W21-S2-10		—	580051	580091	—	—

• See footnote on page 8.

Cartridge Valve Inserts

Spool Type	Functional Symbol	Area Ratio $A_A : A_{AP}$	Cracking Pressure ○		Insert Assembly Numbers ●					Model Codes
			A B	B A	16mm	25mm	40mm	50mm	63mm	
Basic Spool		1 : 1	2.0	X	579976	580259	580321			CVI-••-D10-2-10
		1 : 1.1	0.3	3.4	580019	580064	579929	589111	589134	CVI-••-D11-2-L-10
		1 : 1.1	1.4	17	580020	580065	579930	589112	589135	CVI-••-D11-2-M-10
		1 : 1.1	2.7	34	580021	580066	579931	589113	589136	CVI-••-D11-2-H-10
		1 : 2	0.5	0.5	580022	580067	579932	589114	589137	CVI-••-D20-2-L-10
		1 : 2	2.5	2.5	580023	580068	579933	589115	589138	CVI-••-D20-2-M-10
		1 : 2	5	5	580024	580069	579934	589116	589139	CVI-••-D20-2-H-10
Damping Spool		1 : 2	0.5	0.5	580025	580070	579935	589117	589140	CVI-••-F-2-L-10
		1 : 2	2.5	2.5	580026	580071	579936	589118	589141	CVI-••-F-2-M-10
		1 : 2	5	5	580027	580072	579937	589119	589142	CVI-••-F-2-H-10
Orifice (A X)		1 : 1.1	0.3	3.4	580028	580073	579938			CVI-••-D11-2-L-10-12
		1 : 1.1	1.4	17	580029	580074	579939			CVI-••-D11-2-M-10-12
		1 : 1.1	2.7	34	580030	580075	579940			CVI-••-D11-2-H-10-12

WEIGHT

Components		Kg (Lbs.)				
		16mm	25mm	40mm	50mm	63mm
Cartridge Parts		0.13 (.29)	0.33 (.73)	1.35 (3.0)	2.2 (4.8)	5.4 (11.9)
Cover Assemblies:						
Ref. A F or J		0.83 (1.8)	1.8 (4.0)	5.94 (13.1)	9.7 (21.3)	20.0 (44)
Ref. B or C		On request				
Ref. E		On request				
Ref. K or L with	single solenoid pilot valve	—	4.2 (9.2)	7.64 (16.8)	—	—
	double solenoid pilot valve	—	4.6 (10.1)	8.04 (17.7)	—	—
Ref. H with	single solenoid pilot valve	—	—	—	14.2 (31.2)	24.5 (54)
	double solenoid pilot valve	—	—	—	15.2 (33.4)	25.5 (56)

Weight of a complete cartridge assembly is obtained by summing the separate values for cartridge parts and cover assembly.

MOUNTING ATTITUDE
Unrestricted.

ORDERING PROCEDURE
Ask your Vickers representative for a quotation on a cartridge valve system tailored to your application, or quote the appropriate assembly numbers in this brochure.

○ Consult your sales engineer before applying flows from B to A port in 1:1.1 ratio values.

● Assembly includes seals for fluids as in paragraph 1 of "Hydraulic Fluids" section, page 4.

MODEL CODE

Inserts

F* - CVI - 16 - D20 - 2 - L - 10 - ■ - ■

1 2 3 4 5 6 7 8 9

1 Special Seals

See "Hydraulic Fluids" note, page 4.

2 Cartridge Valve Insert

3 Valve Size

16 - 16mm
25 - 25mm
40 - 40mm
50-50mm
63-63mm

4 Function

D10 - Directional 1:1 (for relief use spring H only).
D11 - Directional 1:1.1
D20 - Directiona' 1:2
F - Damping

5 Seals

1 - DIN 3770 (Europe)
2 - ISO 3601 (Europe and USA)
3 - JIS B2401 (Japan)

6 Spring

Cracking Pressure (Bar)

	D10	D11	D20	F
L -	-	0.3	0.5	0.5
M -	-	1.4	2.5	2.5
H -	2.0	2.7	5.0	5.0

7 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

8 Model Suffix

For special features.

9 Orifices

Blank - Omit
D11 Only
08 - 0.8mm diameter
10 - 1.0mm diameter
12 - 1.2mm diameter
14 - 1.4mm diameter
16 - 1.6mm diameter
18 - 1.8mm diameter
20 - 2.0mm diameter

MODEL CODE

Covers

F* - CVC - 16 - D1 - S2 - M - ■ - 10 - ■ - ■

1 2 3 4 5 6 7 8 9 10

1 Special Seals

See "Hydraulic Fluids" note. page 4.

2 Cartridge Valve Cover

3 Valve Size

16 - 16mm
25 - 25mm
40 - 40mm
50 - 50mm
63 - 63mm

4 Function

N - Basic
D1 - NFPA D01 (with inch threads), 25 & 40 mm only.
D2 - NFPA D02 (with inch threads), 50 & 63 mm only.
PC - Pilot operated check.
W - Shuttle.
W11 - Shuttle type 1, NFPA D01 (with inch threads), 25 & 40 mm only.
W21 - Shuttle type 2, NFPA D01 (with inch threads), 25 & 40 mm only.
A - Stroke adjuster.

5 Seals, Plugs, Bolts

(S2, B19, B29, etc.)

Codes
For Plugs:
B - BSP thread (Europe)
S - SAE thread (USA)
For Seals:
1 - DIN 3770 (Europe)
2 - ISO 3601 (Europe and USA)
3 - JIS B2401 (Japan)
For Bolts:
9 - With metric bolts (Europe)
Blank - Without any bolts (USA)

6 Adjustment Device

Blank - Not required
M - Micrometer
K - With key lock
W - With locknut

7 Pressure Range

Blank - Omit

8 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

9 Model Suffix

For special features.

10 Orifices

Omit if basic.
Deviations in location or size should be specified, e.g. "no orifice in AP port; 1.2mm orifice in Z2" should be coded "AP99-Z212" (see code below).

Codes
Pilot ports are X, Y, Z1, Z2 and AP.
08 - 0.8mm orifice
14 - 1.4mm orifice
99 - No orifice
00 - Plug

Examples
X08 - Orifice 0.8mm in port X
Z112 - Orifice 1.2mm in port Z1
Y99 - No orifice in port Y
Z200 - Plug in port Z2

INSTALLATION DIMENSIONS
Covers Without Stroke Limiters and Pilot Valve Mounting Surfaces

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
16mm	.312-18 x 1.50	BKDNG16-700	26
25mm	.500-13 x 1.50	BKDPNG25-704	81
40mm	.750-10 x 2.25	BKDPNG40-706	370
50mm	.750-10 x 3.00	BKDNG50-708	429
63mm	1.250-7 x 3.50	BKDNG63-710	888

All cover bolts are UNC, grade 8 or better.

Dimensions — mm (in.)

Sizes	A	B	C	P
16mm	65 (2.55)	35 (1.37)	10.0 (.39)	44 (1.73)
25mm	85 (3.34)	42 (1.65)	4.5 (.17)	53 (2.08)
40mm	125 (4.92)	61 (2.40)	3.0 (.11)	76 (2.99)
50mm	140 (5.51)	70 (2.75)		88 (3.46)
63mm	180 (7.08)	80 (3.38)		106 (4.17)

* Minimum for withdrawal.
• For recess dimension see page 12.

▲ Note:
Port "B" is connected to the system load. The pilot pressure of "x" must be at least 30 percent of the load pressure, the latter including any intensification that may occur, e.g. when controlling double-acting cylinders.

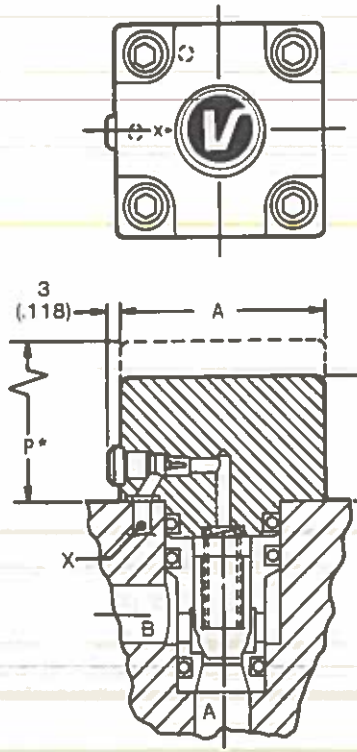
Covers Without Stroke Limiters and Pilot Valve Mounting Surfaces

Sizes 16mm, 25mm, 40mm, 50mm, and 63mm

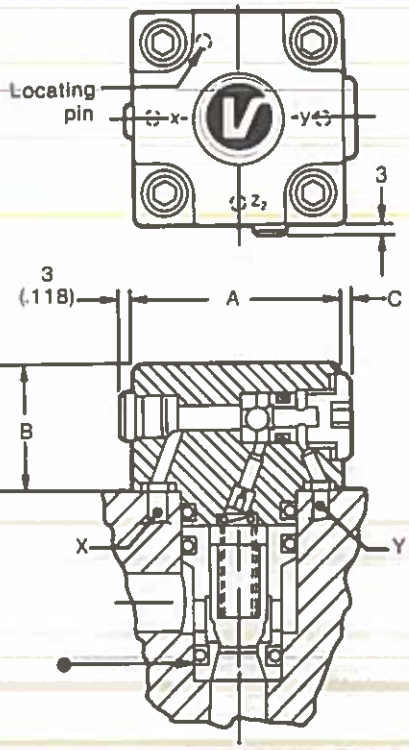
Dimensions Shown in Millimeters and (Inches)

3rd Angle Projection

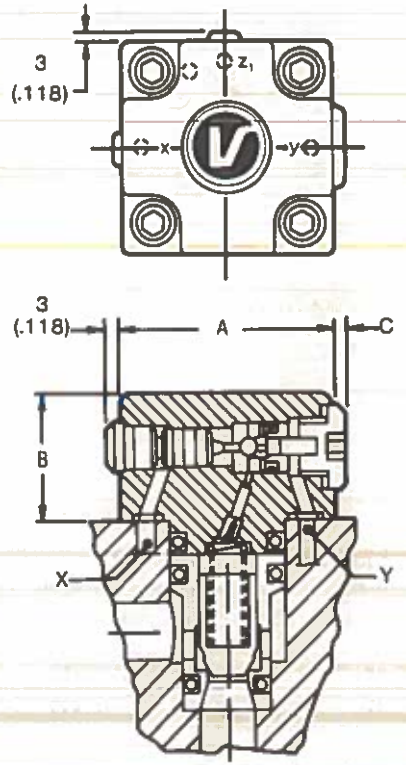
Basic cover (ref. A, page 6)
Sizes: 16, 25, 40, 50, 63mm



Cover (ref. J, page 6) with shuttle valve
Sizes: 16, 25, 40mm



Cover (ref. F, page 6) for pilot operated check function ▲
Sizes: 16, 25, 40mm



Printed in U.S.A.

INSTALLATION DIMENSIONS
Covers With Stroke Limiters

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
16mm	.312-18 x 1.50	BKDNG16-700	26
25mm	.500-13 x 1.50	BKDPNG25-704	81
40mm	.750-10 x 2.25	BKDPNG40-706	370
50mm	.750-10 x 3.00	BKDNG50-708	429
63mm	1.250-7 x 3.50	BKDNG63-710	888

All cover bolts are UNC, grade 8 or better.

Dimensions — mm (in.)

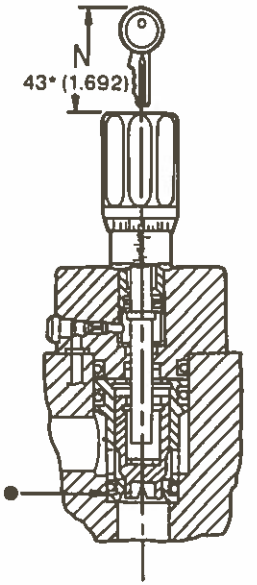
Sizes	A	B	K	L	M
16mm	65 (2.55)	35 (1.37)	74.5 (2.93)	91 (3.58)	—
25mm	85 (3.34)	42 (1.65)	74.5 (2.93)	98 (3.85)	—
40mm	125 (4.92)	60 (2.36)	—	—	43 (1.69)
50mm	140 (5.51)	70 (2.75)	—	—	57 (2.24)
63mm	180 (7.08)	86 (3.38)	—	—	66 (2.59)
Sizes	N A/F	O A/F	Q	R	S
16mm	—	—	137 (5.39)	110 (4.33)	—
25mm	—	—	144 (5.66)	131.5 (5.17)	—
40mm	10	22	—	—	165 (6.49)
50mm	16	36	—	—	183 (7.20)
63mm	17	41	—	—	229 (9.01)

Covers With Stroker Limiters
Sizes 16mm, 25mm, 40mm, 50mm, and 63mm

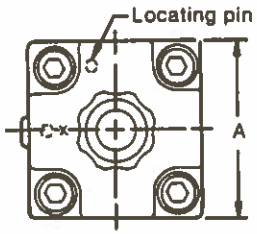
Dimensions Shown in Millimeters and (Inches)

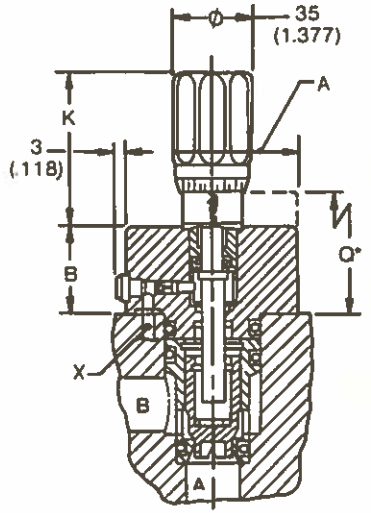
3rd Angle Projection

Cover (ref. C, page 6) with micrometer knob and key-lock
Sizes: 16mm, 25mm

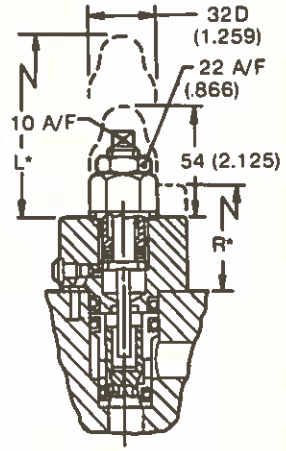


Cover (ref. C, page 6) with micrometer knob and key-lock
Sizes: 16mm, 25mm

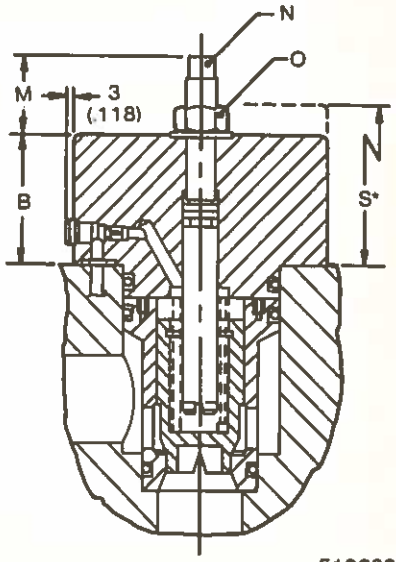




Cover (ref. E, page 6) with set screw adjustment, locknut and cap
Sizes: 16mm, 25mm



Cover (ref D, page 6) with set screw adjustment and locknut
Sizes: 40mm, 50mm, 63mm



* Minimum for withdrawal.
● For recess dimensions see page 12.

519200-9

INSTALLATION DIMENSIONS
Covers with NFPA-D01 (ISO-4401-3) Mounting Surfaces

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
25mm	.500-13 x 1.50	BKDPNG25-704	81
40mm	.750-10 x 2.25	BKDPNG40-706	370

All cover bolts are UNC, grade 8 or better.

Dimensions — mm (in.)

Sizes	A	D		E		H	J
25mm	85 (3.34)	38.0 (1.50) AC	52.0 (2.05) DC	98.85 (3.89) AC	112.85 (4.44) DC	39 (1.53)	7 (2.24)
40mm	125 (4.92)	38.0 (1.50) AC	52.0 (2.05) DC	98.85 (3.89) AC	112.85 (4.44) DC	58 (2.28)	58 (2.28)

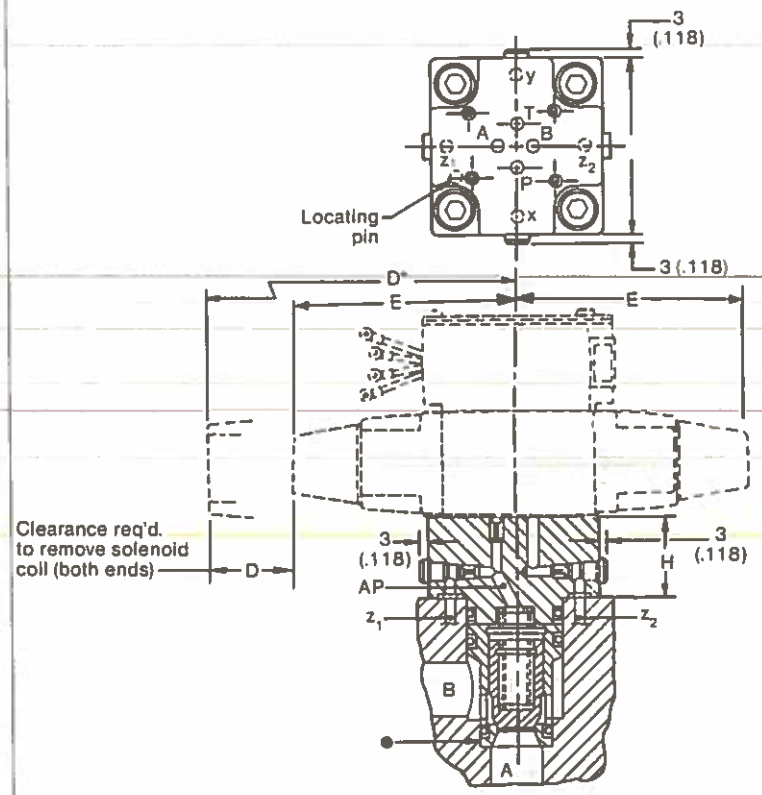
Covers With NFPA-D01 (ISO-4401-3) Mounting Surfaces

Sizes 25mm and 40mm

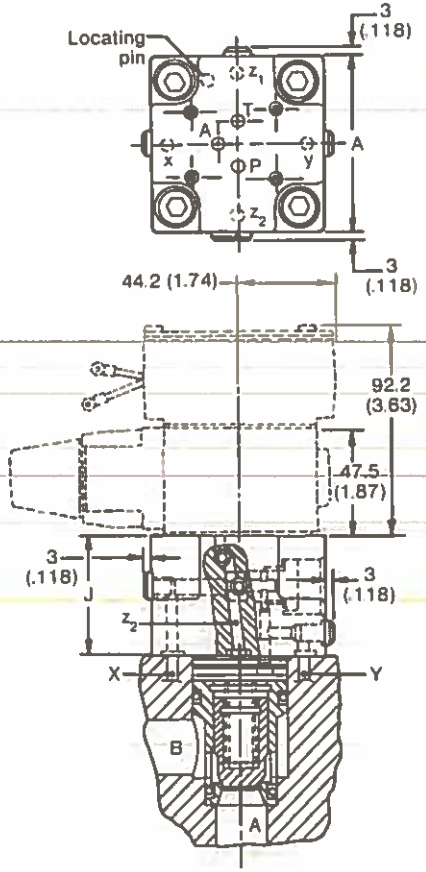
Dimensions Shown In Millimeters And (Inches)

3rd Angle Projection

Cover (ref. G, page 6)
(Shown with double solenoid pilot valve ▲)



Cover (refs. K & L, page 6) with pilot shuttle valves
(Shown with single solenoid spring-offset pilot valve ▲)



● For recess dimensions see page 12.

▲ For details of these DG4V-3 series valves, see installation drawing 517351.

519200-10

Revised 8-85

INSTALLATION DIMENSIONS
Covers With NFPA-D02(ISO-4401-5) Mounting Surfaces

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
50mm	.750-10 x 3.00	BKDNG50-708	429
63mm	1.250-7 x 3.50	BKDNG63-710	888

All cover bolts are UNC, grade 8 or better.

Dimensions — mm (in.)

Sizes	A	D	E	H	J
50mm	140 (5.51)	222.3 (8.75)	133.4 (5.25)	68 (2.67)	157.2 (6.18)
63mm	180 (7.08)	222.3 (8.75)	133.4 (5.25)	83 (3.26)	172.2 (6.77)

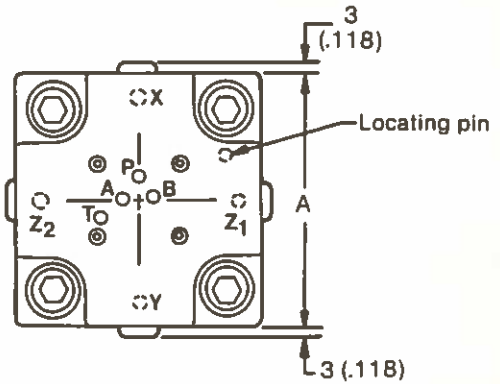
Covers With NFPA-D02 (ISO-4401-5) Mounting Surfaces

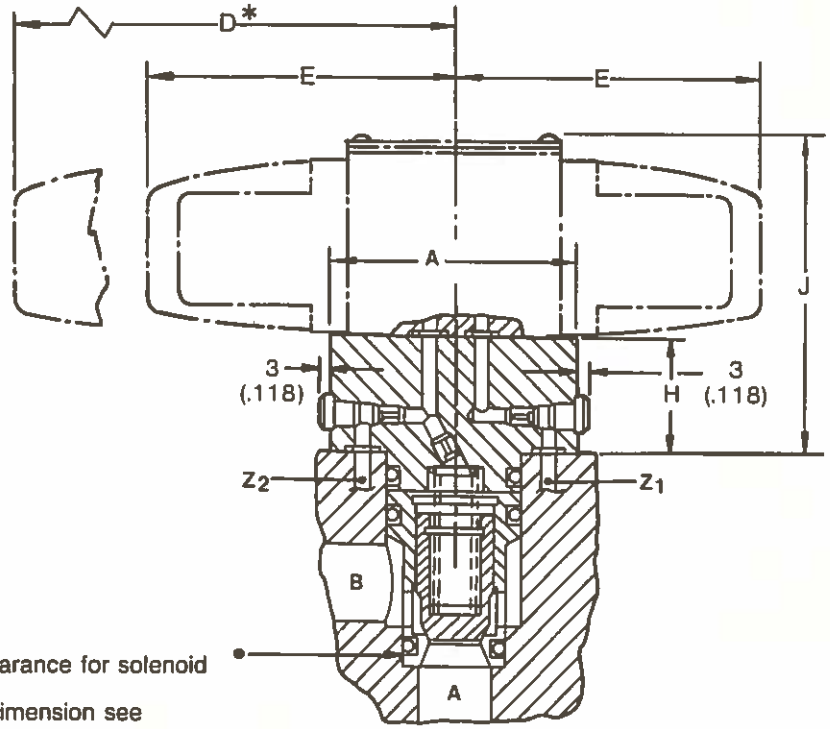
Sizes 50mm and 63mm

Dimensions Shown In Millimeters And (Inches)

3rd Angle Projection

Cover (ref. H, page 6)
(Shown with double solenoid pilot valve ▲)





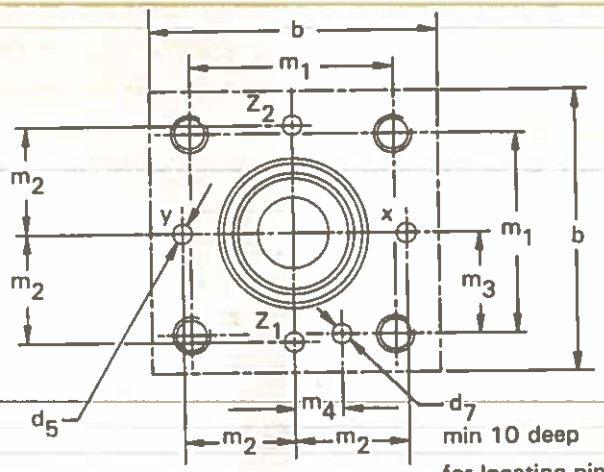
* Minimum clearance for solenoid coil removal.
● For recess dimension see page 12.
▲ For details of these DG4S4-01 series valves, see installation drawing 517401 or 517410.

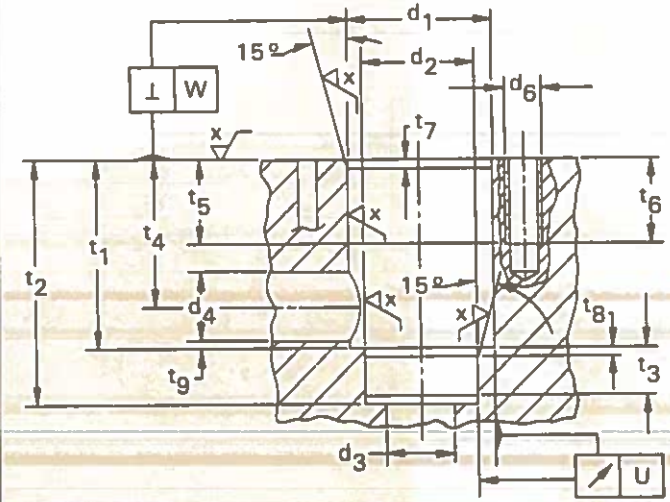
Recess Dimensions To DIN 24342

Dimension	Nominal Size - Metric (Inches)				
	16mm	25mm	40mm	50mm	63mm
b	65 (2.56)	85 (3.35)	125 (4.92)	140 (5.51)	180 (7.09)
d_1	32.000 (1.2598) 32.025 (1.2608)	45.000 (1.7717) 45.025 (1.7726)	75.000 (2.9528) 75.030 (2.9539)	90.000 (3.5433) 90.035 (3.5447)	120.000 (4.7244) 120.035 (4.7258)
d_2	25.000 (0.9843) 25.021 (0.9851)	34.000 (1.3386) 34.025 (1.3396)	55.000 (2.1653) 55.030 (2.1665)	68.000 (2.6772) 68.030 (2.6783)	90.000 (3.5433) 90.035 (3.5447)
d_3 maximum	16 (.63)	25 (.98)	40 (1.57)	50 (1.97)	63 (2.48)
d_4	16 (.63)	25 (.98)	40 (1.57)	50 (1.97)	63 (2.48)
d_4 maximum	25 (.98)	32 (1.26)	50 (1.97)	63 (2.48)	80 (3.15)
d_5 maximum	4 (.157)	6 (.236)	10 (.393)	10 (.393)	12 (.472)
d_6 Thread	M8 (.3125-18)	M12 (.500-13)	M20 (.750-10)	M20 (.750-10)	M30 (1.250-7)
d_7	4.000 (.1575) 4.180 (.1646)	6.000 (.2362) 6.180 (.2433)	6.000 (.2362) 6.180 (.2433)	8.000 (.3150) 8.220 (.3236)	8.000 (.3150) 8.220 (.3236)
m_1 $\pm 0.2(\pm .008)$	46 (1.811)	58 (2.284)	85 (3.347)	100 (3.937)	125 (4.921)
m_2 $\pm 0.2(\pm .008)$	25 (.984)	33 (1.299)	50 (1.969)	58 (2.284)	75 (2.953)
m_3 $\pm 0.2(\pm .008)$	23 (.906)	29 (1.142)	42.5 (1.674)	50 (1.969)	62.5 (2.461)
m_4 $\pm 0.2(\pm .008)$	10.5 (.414)	15 (.630)	23 (.906)	30 (1.181)	38 (1.496)
t_1 $+0.1(+.004)$	43 (1.692)	58 (2.283)	87 (3.425)	100 (3.937)	130 (5.118)
t_2 $+0.1(+.004)$	56 (2.204)	72 (2.834)	105 (4.133)	122 (4.803)	155 (6.103)
t_3*	11 (.433)	12 (.472)	15 (.590)	17 (.669)	20 (.787)
t_4	34 (1.338)	44 (1.732)	64 (2.519)	72 (2.834)	95 (3.740)
t_4 to d_4 maximum	29.5 (1.161)	40.5 (1.594)	59 (2.322)	65.5 (2.578)	86.5 (3.405)
t_5*	20 (.787)	30 (1.181)	30 (1.181)	35 (1.377)	40 (1.574)
t_6 Thread Depth	20 (.787)	25 (.984)	35 (1.377)	40 (1.574)	55 (2.165)
t_7	2 (.078)	2.5 (.098)	3 (.118)	4 (.157)	4 (.157)
t_8	2 (.078)	2.5 (.098)	3 (.118)	3 (.118)	4 (.157)
t_9	1.5 (.059)	1.5 (.059)	3 (.118)	3 (.118)	3 (.118)
U	0.03 (.0012)	0.03 (.0012)	0.05 (.0020)	0.05 (.0020)	0.05 (.0020)
W	0.05 (.002)	0.05 (.002)	0.1 (.0039)	0.1 (.0039)	0.2 (.0079)
X_{Ra}		1.6 micrometer (63 microinches)			

*Depth of finish "X_{Ra}" in hole.

Recess Dimensions To DIN 24342



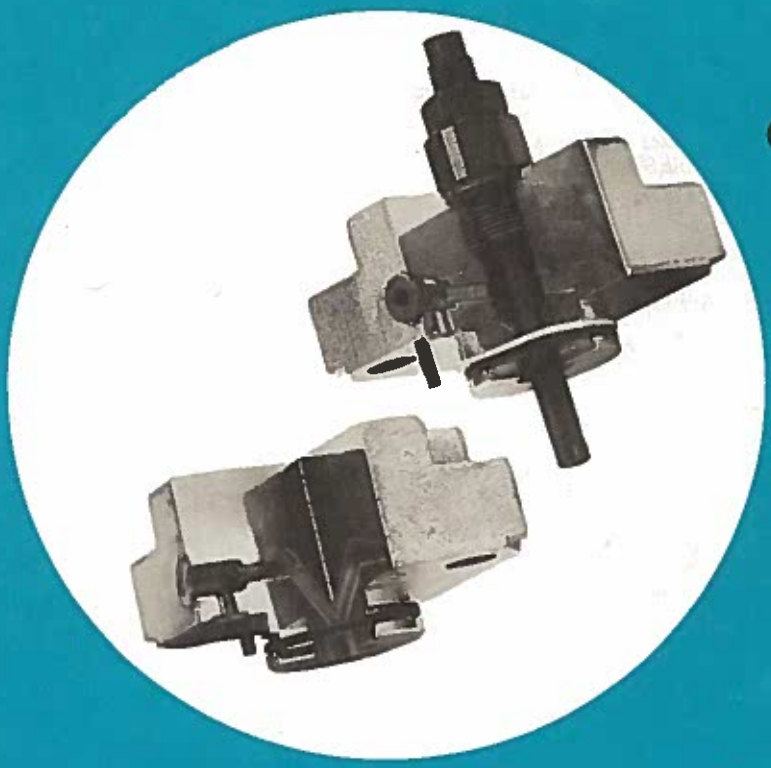


519200-12

Revised 8-85

SPERRY VICKERS

24



TWO-WAY CARTRIDGE VALVES

OVERHAUL MANUAL

DIRECTIONAL VALVES (Covers & Inserts)
PILOT OPERATED CHECK VALVES
SHUTTLE VALVES

VARYING FROM USUAL MODEL CODE NAMEPLATE DESIGNATION, COVER S/A NUMBERS ARE STAMPED INTO THE 2-WAY CARTRIDGE VALVE NAMEPLATE. A CROSS REFERENCE BETWEEN COVER S/A NUMBERS AND THE MODEL CODE IS SHOWN ON PAGE "ii". AN ASSEMBLY VERSUS MODEL CODE CROSS REFERENCE FOR CARTRIDGE VALVE INSERTS IS ALSO INCLUDED.

Released 12-1-82

SPERRY VICKERS, TROY, MI 48084
VICKERS, INCORPORATED, IS A SUBSIDIARY OF SPERRY CORPORATION
SPERRY VICKERS IS A REGISTERED TRADEMARK OF SPERRY CORPORATION

I-3638-S

TABLE OF CONTENTS

SECTION		PAGE
I	INTRODUCTION	
	A. Purpose of Manual	1
	B. General Information	1
	C. Model Code	2
II	DESCRIPTION	
	A. General	2
	B. Cover Construction	3
	1. Directional (Standard)	3
	2. Covers with Stroke Adjustment	3
	3. Directional (NFPA-D01)	3
	4. Directional (NFPA-D02)	3
	5. Pilot Operated Check	3
	6. Shuttle (Standard)	4
	7. Shuttle (with NFPA-D01) Interface	4
	C. Cartridge Valve Insert Kits	4
	1. Sleeve Sizes and Flows	4
	2. Available Spool Types	4
III	PRINCIPLES OF OPERATION	
	A. General	6
	B. Standard Covers	6
	C. Stroke Adjustment Covers	7
	D. Pilot Valve Interface Covers	7
	E. Pilot Operated Check Covers	8
	F. Shuttle Valve Covers (Standard)	8
	G. Shuttle Valve Covers (with Interface)	10
	H. Cartridge Valve Insert Kit	11
IV	INSTALLATION AND OPERATING INSTRUCTIONS	
	A. Installation Drawings	12
	B. Mounting	12
	C. Piping and Tubing	12
	D. Hydraulic Fluid Recommendations	12
	General Data	12
	Cleanliness	12
	Sound Level	12
	E. Overload Protection	12
	F. Replacement Parts	12
	G. Troubleshooting	12
V	SERVICE AND MAINTENANCE	
	A. Service Tools	13
	B. Inspection	13
	C. Adding Fluid to the System	13
	D. Adjustments	13
	E. Lubrication	13
VI	OVERHAUL	
	A. Standard Covers	13
	B. Covers with Stroke Adjustment	13
	Disassembly Procedure for Micrometer Knob Type Stroke Adjuster	18
	Assembly Procedure for Micrometer Knob Type Stroke Adjuster	18
	Disassembly Procedure for Micrometer Knob with Keylock Type Stroke Adjuster	18
	Assembly Procedure for Micrometer Knob with Keylock Type Stroke Adjuster	18
	C. Covers with Pilot Valve Interface	18
	D. Covers with Pilot Operated Check Valves	20
	E. Covers with Shuttle Valves	20
	F. Covers with Shuttle Valves and Pilot Valve Interface	20
	G. Determining Cartridge Valve Insert Kit Assembly Number	24

ASSEMBLY/MODEL CODE CROSS REFERENCE

Std. Cover Assy. No.	Model Code Breakdown
580006	CVC-16-N-S2-10
580045	CVC-25-N-S2-10
580085	CVC-40-N-S2-10
589120	CVC-50-N-S2-10
589143	CVC-63-N-S2-10
Stroke Adj. Covers	Model Code Breakdown
580007	CVC-16-A-S2-M-10
580008	CVC-16-A-S2-K-10
580009	CVC-16-A-S2-W-10
580046	CVC-25-A-S2-M-10
580047	CVC-25-A-S2-K-10
580053	CVC-25-A-S2-W-10
580086	CVC-40-A-S2-W-10
589121	CVC-50-A-S2-W-10
589144	CVC-63-A-S2-W-10
NFPA-D01/ ISO4401-3 Covers	Model Code Breakdown
580048	CVC-25-D1-S2-10
580088	CVC-40-D1-S2-10
NFPA-D02/ ISO4401-5 Covers	Model Code Breakdown
589122	CVC-50-D2-S2-10
589145	CVC-63-D2-S2-10
Pilot Operated Check Cover	Model Code Breakdown
580011	CVC-16-PC-S2-10
580052	CVC-25-PC-S2-10
580087	CVC-40-PC-S2-10
Shuttle Valve Covers	Model Code Breakdown
580010	CVC-16-W-S2-10
580049	CVC-25-W-S2-10
580089	CVC-40-W-S2-10
Shuttle Valve NFPA-D01/ ISO4401-3 Interface, Type 1	Model Code Breakdown
580050	CVC-25-W11-S2-10
580090	CVC-40-W11-S2-10
Shuttle Valve NFPA-D01/ ISO4401-3 Interface, Type 2	Model Code Breakdown
580051	CVC-25-W21-S2-10
580091	CVC-40-W21-S2-10

Cart. Insert Kits Standard	Model Code Breakdown
579929	CVI-40-D11-2-L-10
579930	CVI-40-D11-2-M-10
579931	CVI-40-D11-2-H-10
579932	CVI-40-D20-2-L-10
579933	CVI-40-D20-2-M-10
579934	CVI-40-D20-2-H-10
579976	CVI-16-D10-2-H-10
580019	CVI-16-D11-2-L-10
580020	CVI-16-D11-2-M-10
580021	CVI-16-D11-2-H-10
580022	CVI-16-D20-2-L-10
580023	CVI-16-D20-2-M-10
580024	CVI-16-D20-2-H-10
580064	CVI-25-D11-2-L-10
580065	CVI-25-D11-2-M-10
580066	CVI-25-D11-2-H-10
580067	CVI-25-D20-2-L-10
580068	CVI-25-D20-2-M-10
580069	CVI-25-D20-2-H-10
580259	CVI-25-D10-2-10
580321	CVI-40-D10-2-10
589111	CVI-50-D11-2-L-10
589112	CVI-50-D11-2-M-10
589113	CVI-50-D11-2-H-10
589114	CVI-50-D20-2-L-10
589115	CVI-50-D20-2-M-10
589116	CVI-50-D20-2-H-10
589134	CVI-63-D11-2-L-10
589135	CVI-63-D11-2-M-10
589136	CVI-63-D11-2-H-10
589137	CVI-63-D20-2-L-10
589138	CVI-63-D20-2-M-10
589139	CVI-63-D20-2-H-10
Insert With Dampening (Metering)	Model Code Breakdown
579935	CVI-40-F-2-L-10
579936	CVI-40-F-2-M-10
579937	CVI-40-F-2-H-10
580025	CVI-16-F-2-L-10
580026	CVI-16-F-2-M-10
580027	CVI-16-F-2-H-10
580070	CVI-25-F-2-L-10
580071	CVI-25-F-2-M-10
580072	CVI-25-F-2-H-10
589117	CVI-50-F-2-L-10
589118	CVI-50-F-2-M-10
589119	CVI-50-F-2-H-10
589140	CVI-63-F-2-L-10
589141	CVI-63-F-2-M-10
Insert Orifice Type	Model Code Breakdown
579938	CVI-40-D11-2-L-12-10
579939	CVI-40-D11-2-M-12-10
579940	CVI-40-D11-2-H-12-10
580028	CVI-16-D11-2-L-12-10
580029	CVI-16-D11-2-M-12-10
580030	CVI-16-D11-2-H-12-10
580073	CVI-25-D11-2-L-12-10
580074	CVI-25-D11-2-M-12-10
580075	CVI-25-D11-2-H-12-10

A. PURPOSE OF MANUAL

This manual describes the basic operating characteristics and provides service and overhaul information for Sperry Vickers directional, pilot operated check, and shuttle cartridge valves.

B. GENERAL INFORMATION

Related publications - Installation dimenstions are not contained in this manual. Cartridge valve installation information is listed in Table 1. Installation drawings are available from any Sperry Vickers sales engineering office or from:

Sperry Vickers
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

CARTRIDGE VALVE TYPE	INSTALLATION DRAWINGS				
	16mm	25mm	40mm	50mm	63mm
Directional Valve Pilot Operated Check Valve Shuttle Valves	Installation information shown in Advertising Bulletin "316".				

Table 1. Related Publications

MODEL CODE BREAKDOWN

CVC - ** - ** - S2 - * - 10 - * - ***

Cartridge Valve Cover

Valve Size (mm)
-16
-25
-40
-50
-63

Function
A Stroke Adjuster (all)
D1 NFPA-D01 with inch threads (25 & 40mm only)
D2 NFPA-D02 with inch threads (50 & 63mm only)
N Standard Directional (all sizes)
PC Pilot Operated Check (16, 25 & 40mm)
W Shuttle (16, 25 & 40mm)
W11 Shuttle Type 1, NFPA-D01 with inch threads
W21 Shuttle Type 2, NFPA-D01 with inch threads

SAE Thread Plugs

ISO 3601 Seals

Orifices
Pilot ports X, Y, Z1, Z2 and 'AP' can be provided with an orifice.
08 = 0.8mm Orifice
12 = 1.2mm Orifice
99 = No Orifice
00 = Plug

Examples:
X08 = Orifice 0.8 in Port X
Z112 = Orifice 1.2 in Port Z1
Y99 = No Orifice in Port Y
Z200 = Plug in Port Z2

Model Suffix

Design Number
-10

Adjustment Devices	Stroke Adjust
- H - Handwheel	-
- M - Micrometer	16 & 25mm
- K - With Key Lock	16 & 25mm
- W - With Locknut	All
Blank - Not Req'd.	-

Table 2. Model Code Breakdown - Cover Section

C. MODEL CODES

Cartridge valve cover variations are listed in the model code breakdown, Table 2. The cover section model code/assembly number, stamped on the nameplate, does not identify cartridge valve inserts.

Cartridge valve insert variations are listed in the model code breakdown, Table 3. To identify valve insert parts, refer to "VALVE INSERT IDENTIFICATION" Section VI-G of this manual.

MODEL CODE BREAKDOWN

CVI - ** - * - 2 - * - 10 - ** - **

Cartridge Valve Insert

Valve Size (mm)
- -16
- -25
- -40
- -50
- -63

Function
- -D10 Directional 1:1
- -D11 Directional 1.1:1
- -D20 Directional 2:1
- -F Metering 2:1

Seals
-2 - ISO 3601

Design Number
-10

Spring Cracking Pressure (bar)

	D10	D11	D20	F
-L	—	0.3	0.5	0.5
-M		1.4	2.5	2.5
-H	2.0	2.7	5.0	5.0

Model Suffix

Orifices (D11 Only)

Blank	Omit
-08	0.8 mm diameter
-10	1.0 mm diameter
-12	1.2 mm diameter
-14	1.4 mm diameter
-16	1.6 mm diameter
-18	1.8 mm diameter
-20	2.0 mm diameter

Table 3. Model Code Breakdown - Cartridge Valve Insert

Section II - DESCRIPTION

A. GENERAL

Cartridge valves consist of two sections which are assembled into a manifold. One section is called the cover section and the other is called the cartridge valve insert section. Internal cover parts vary according to a particular cover type. The following cover types are available (see Table 4). An exploded view showing item numbers for disassembly and assembly sequence along with appropriate part numbers can be found in section VI.

COVER TYPE	LOCATION
Directional (Standard)	VI-A
Stroke Adjustment Cover	VI-B
Directional (NFPA-D01) Interface	VI-C
Directional (NFPA-D02) Interface	VI-C
Pilot Operated Check	VI-D
Shuttle (Standard)	VI-E
Shuttle (NFPA-D01) Interface	VI-F

Table 4. Internal Cover Parts Location in Manual

B. COVER CONSTRUCTION

NOTE
Cartridge valve covers are mounted to the manifold with four (4) cap screws. The cover retains the cartridge valve insert within the manifold cavity.

1. Directional (Standard) - The standard cover contains a pilot pressure passage with an orifice to control the spool opening and closing rate. Pilot pressure to control the spool must be obtained from another valve in the system (see Figure 1).

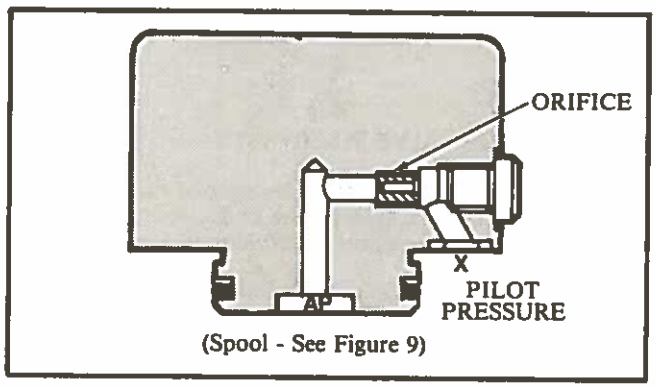


Figure 1. Standard Cover Construction

2. Covers with Stroke Adjustment - A cartridge valve spool can become a flow regulator with the addition of a stroke adjust cover. Stroke adjustment is accomplished by a pin that extends through the cover and limits travel of the spool. Flow through the valve is throttled by the spool to seat opening. The throttle opening is externally adjustable (see Figure 2).

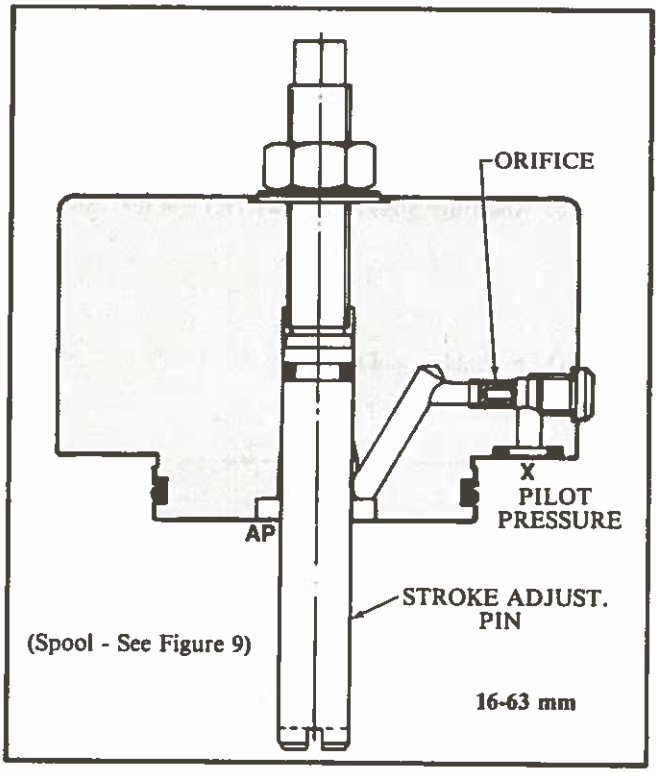


Figure 2. Stroke Adjustment Covers

3. Directional (NFPA-D01) - This cover provides a mounting pad for a directional valve and is available in the 25mm and 40mm sizes. The valve is used to direct pilot pressure to and from the (AP) spring chamber area of the spool. Various orifices are available to control spool opening and closing rates. The DG4V-3 series is a common directional valve used with this cover (see Figure 3).

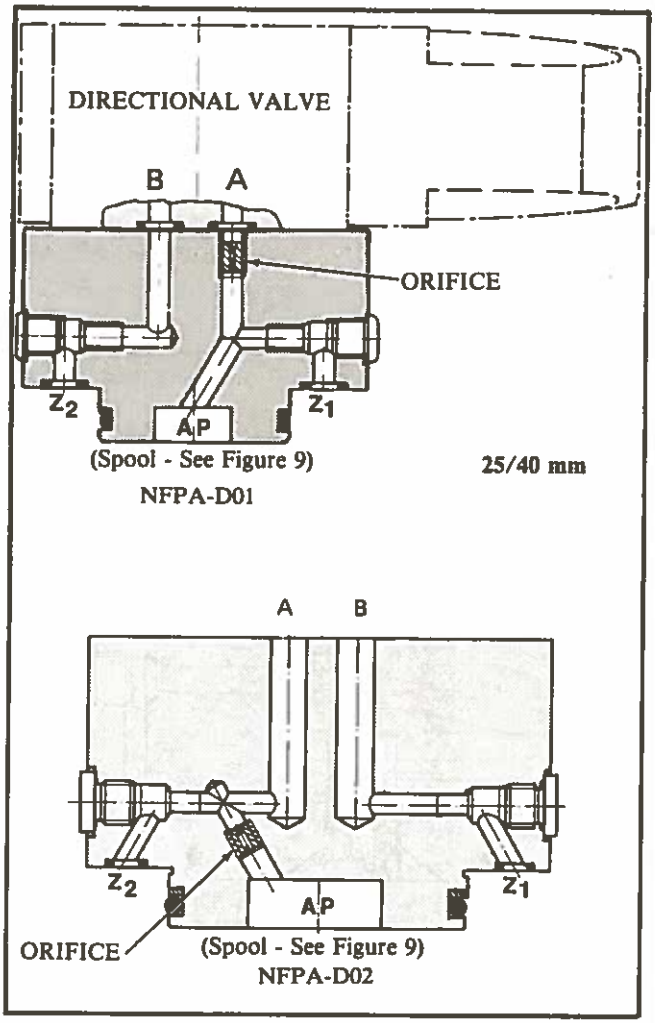


Figure 3. Directional Valve Covers with NFPA-D01 & D02 Mounting Pads

4. Directional (NFPA-D02) - This cover provides the same features as the NFPA-D01 cover. The difference between the covers is the mounting pad which is made to accommodate a larger directional valve. The NFPA-D02 cover is used with the 50mm and 63mm sizes. Please note: The function of the Z* ports change as directional control valve sizes are changed.

5. Pilot Operated Check - (See Figure 4) The pilot operated check valve is available in the 16mm, 25mm and 40mm sizes. Assume pilot pressure is applied to 'X' from the 'A' port. The piston moves to the left and lifts the check valve ball from its seat. This drains pilot (spring) area (AP) of the cartridge valve poppet and allows check valve action. The cartridge valve 'B' port area is connected to 'Y'. When flow reverses, pressure is applied to 'Y' from the 'B' port and removed from 'X'. The spring then shifts the check valve ball and the pilot spring area (AP) is pressurized preventing the cartridge insert spool from opening. Orifices are available to control poppet reaction time.

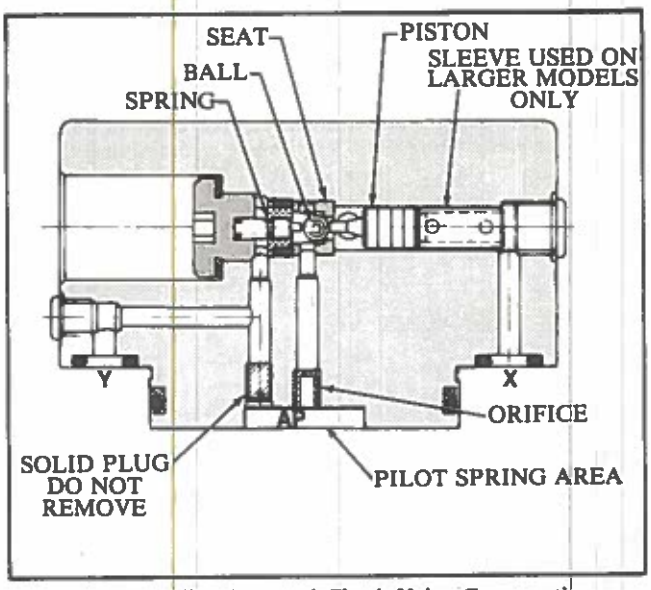


Figure 4. Pilot Operated Check Valve Construction

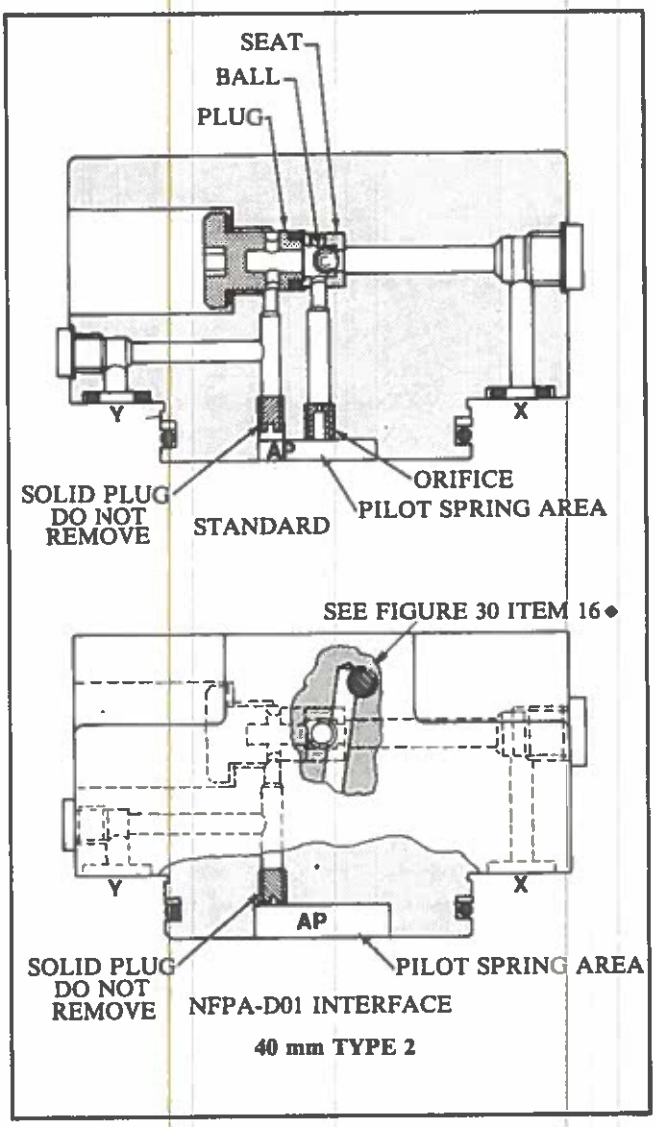


Figure 5. Shuttle Valve Cover Construction

6. Shuttle (Standard) - A shuttle valve cover is a device which will take the higher of two pressures and direct it into pilot spring area (AP) of the cartridge valve insert kit. Orifices are available in the cover to control reaction time of the poppet (see Figure 5).

7. Shuttle with (NFPA-D01) Interface - These shuttle valve covers take the higher of two pressures and directs it through a directional valve to pilot spring area (AP) of the cartridge insert kit. When the directional valve is energized, pressure from the shuttle valve is blocked and pilot spring area (AP) is opened to the Z1 port, tank or reservoir (see Figure 5).

C. CARTRIDGE VALVE INSERT KITS

1. Sleeve Sizes and Flows - Five sizes of cartridge valve insert kits were released. They are the 16, 25, 40, 50 and 63mm sizes. The valve size represents manifold port sizes.

A cartridge valve, unlike a spool valve, does not have a malfunction flow. The valve will open or close regardless of flow; however, pressure drop across the valve will increase as flow increases. Cartridge valves are rated by the amount of flow they will pass with a one (1) or five (5) bar pressure drop "through the valve".

"Through the valve" is exactly what is meant. If a large manifold with complex flow paths is employed, do not expect the pressure drop through the system to be equivalent to "through the valve" (see Table 5).

Valve Size	Port Size mm	Port Size inch	Flow at 1 bar l/m	Flow at 1 bar (GPM)	Flow at 5 bar l/m	Flow at 5 bar (GPM)
16	16	0.63	80	(21)	175	(46)
25	25	0.98	200	(53)	450	(118)
40	40	1.57	500	(132)	1000	(263)
50	50	1.97	550	(145)	1500	(395)
63	63	2.48	1000	(263)	2500	(658)
Note: 1 bar = 14.5 PSI						

Table 5. Cartridge Sizes and Flows Through the Valve

2. The available spool types are:

a. Standard (see Figure 6).

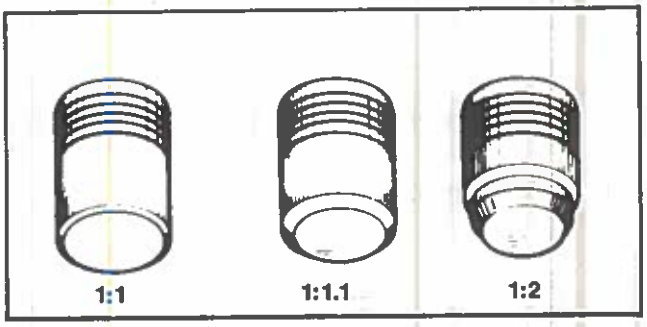


Figure 6. Standard Spools

b. Metering (see Figure 7).

Figure 7. Metering Spool

c. With Orifice (see Figure 8)

Figure 8. Spool with Orifice

3. Spools can be obtained in different area ratios. The area ratio is defined as the spool area 'A' compared to spool area 'AP'. The available area ratios are 1:1, 1:1.1 and 1:2. Refer to Figure 9 for a definition of area ratios.

4. Three springs are available for use with each size cartridge valve insert kit. The springs provide different spool cracking pressures for different area ratios. See Tables 6 and 7 for a tabulation of cracking pressure differences.

Spool cracking pressures with pressure applied to 'A' port. 'AP' port drained.			
SPRING	AREA RATIOS		
TYPE	1.1	1:1.1	1:2
Light	———	0.3 bar	0.5 bar
Medium		1.4 bar	2.5 bar
Heavy	2.5 bar	2.7 bar	5.0 bar

Table 6. Spool Cracking Pressures for Different Area Ratios

Spool cracking pressures with pressure applied to 'B' port. 'AP' port drained.			
SPRING	AREA RATIOS		
TYPE	1:1	1:1.1	1:2
Light	—	3.4 bar	0.5 bar
Medium	—	17.0 bar	2.5 bar
Heavy	—	34.0 bar	5.0 bar

Table 7. Spool Cracking Pressures for Different Area Ratios

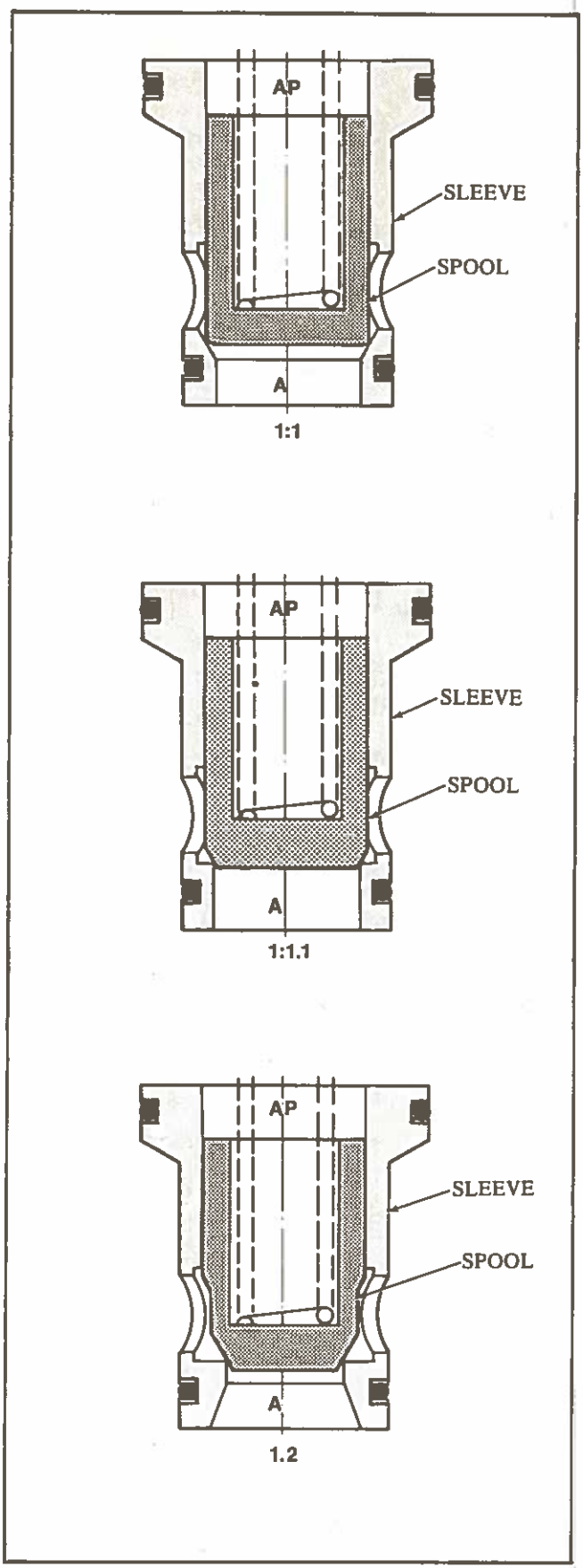


Figure 9. Area Ratios

A. GENERAL

Three types of cartridge valves are covered in this manual: directional valves, pilot operated check valves and shuttle valves.

The complete valve consists of two sections:

1. Cover
2. Cartridge valve insert kit

The cartridge valve insert kit serves as the working section while the cover section controls a particular function.

B. STANDARD COVERS (Refer to Figure 10)

With pilot port 'X' connected to an externally controlled pilot pressure source, this valve becomes a pilot operated directional control. With sufficient pressure at pilot port 'X', the spool is closed and flow between ports 'A' and 'B' is inhibited. With the 'X' pilot port drained to tank, the spool can open and flow will occur from 'A' to 'B'. Spool cracking pressure depends on the insert area ratio and spring force.

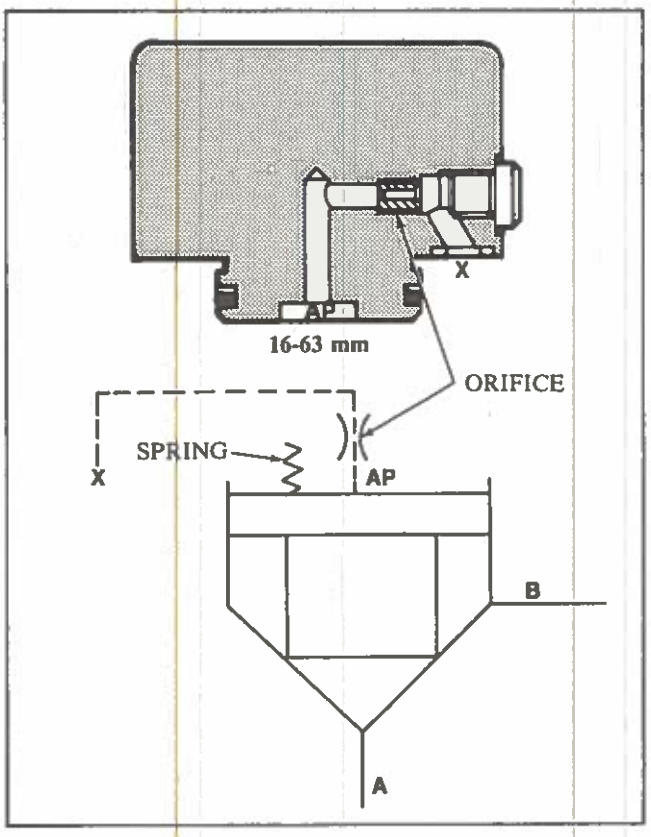


Figure 10. Directional Valve Cover Operation

Cartridge valves with directional covers can also function as a non-return check valve. With the 'X' port connected to either the 'A' or 'B' port, free flow is allowed as shown (see Figures 11 and 12). Reverse flow is prevented by spring force and upstream pilot port pressure at 'X'. When piped as shown in Figure 11, leakage through the insert spool and sleeve diametrical clearances may cause movement of the hydraulic cylinder. This could be a feature if decompression of a load is required. The configuration shown in Figure 12 performs the same function but eliminates leakage through the diametrical clearances.

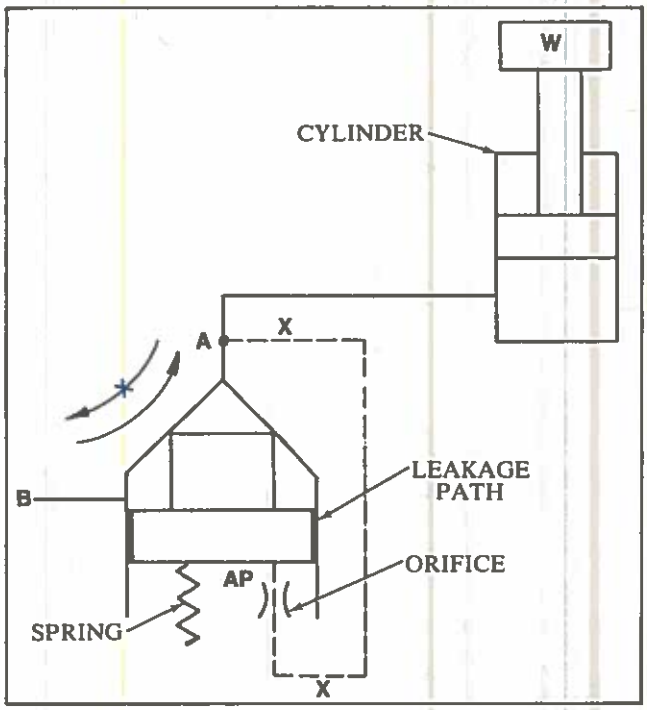


Figure 11. Leakage from Cylinder to 'B' Port

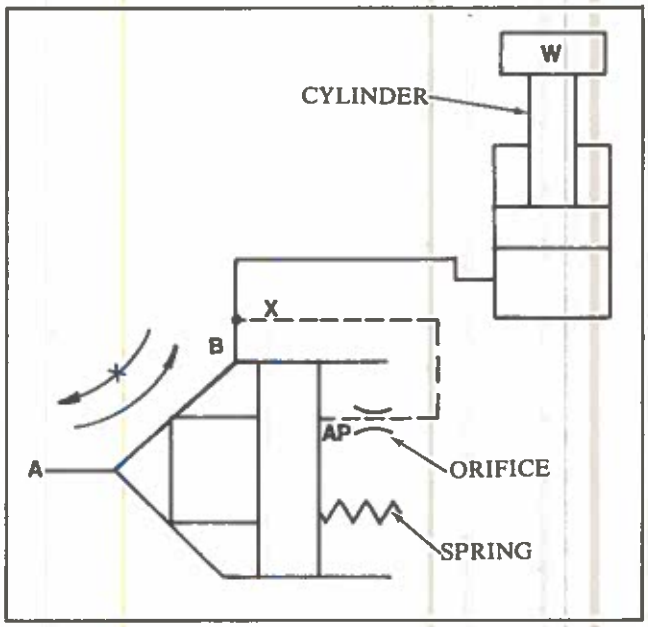


Figure 12. No Leakage

C. STROKE ADJUSTMENT COVERS

Directional covers with stroke adjustment provide flow regulation and directional control in a single unit. Flow regulation is obtained by limiting the travel or stroke of the insert spool. Essentially, an adjustable throttle or variable orifice is created. The throttle opening is set by the position of a pin which extents into the cartridge insert spring chamber. The pin forms a stop to prevent the spool from fully opening.

Four (4) types of adjusters are available: adjustment rod, adjustment rod with cap, micrometer knob, and micrometer knob with key lock. Refer to Figure 13 for basic stroke adjuster construction and parts. Micrometer knobs provide precise incremental control and the capability of returning to a previous setting when desired.

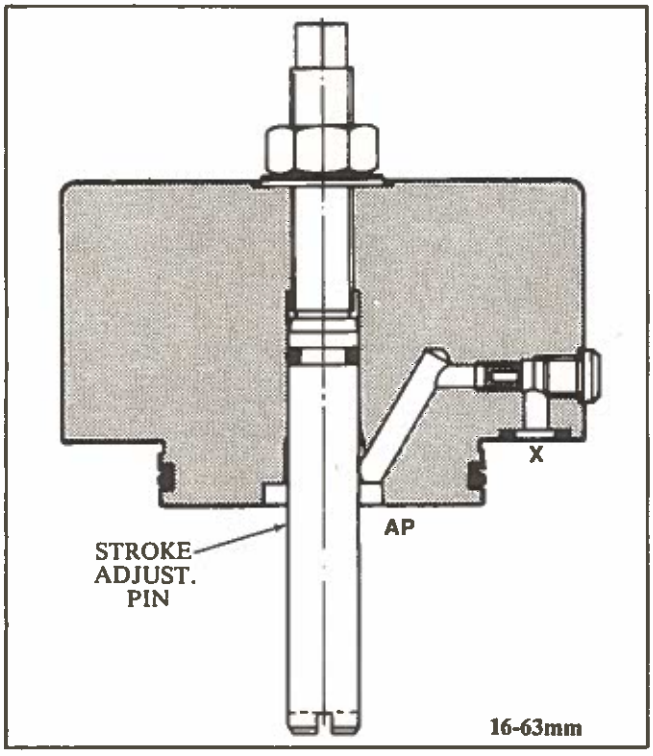


Figure 13. Stroke Adjustment Covers

D. PILOT VALVE INTERFACE COVERS

Cartridge valve covers with a pilot directional valve interface on top are available in all sizes except 16mm. The 25 and 40mm covers have an NFPA-D01 interface for mounting a DG4V-3 pilot valve (see Figure 14). The 50 and 63mm covers have a NFPA-D02 interface which takes a DG4S4-01* pilot valve (see Figure 15). The 16mm cover is to small for a pilot valve mounting pad.

NOTE

The 25 and 40mm covers connect auxiliary port Z1 with the insert spring chamber while the 50 and 63mm covers connect the Z2 port with the insert spring chamber. This is due to the difference in pilot valve port patterns.

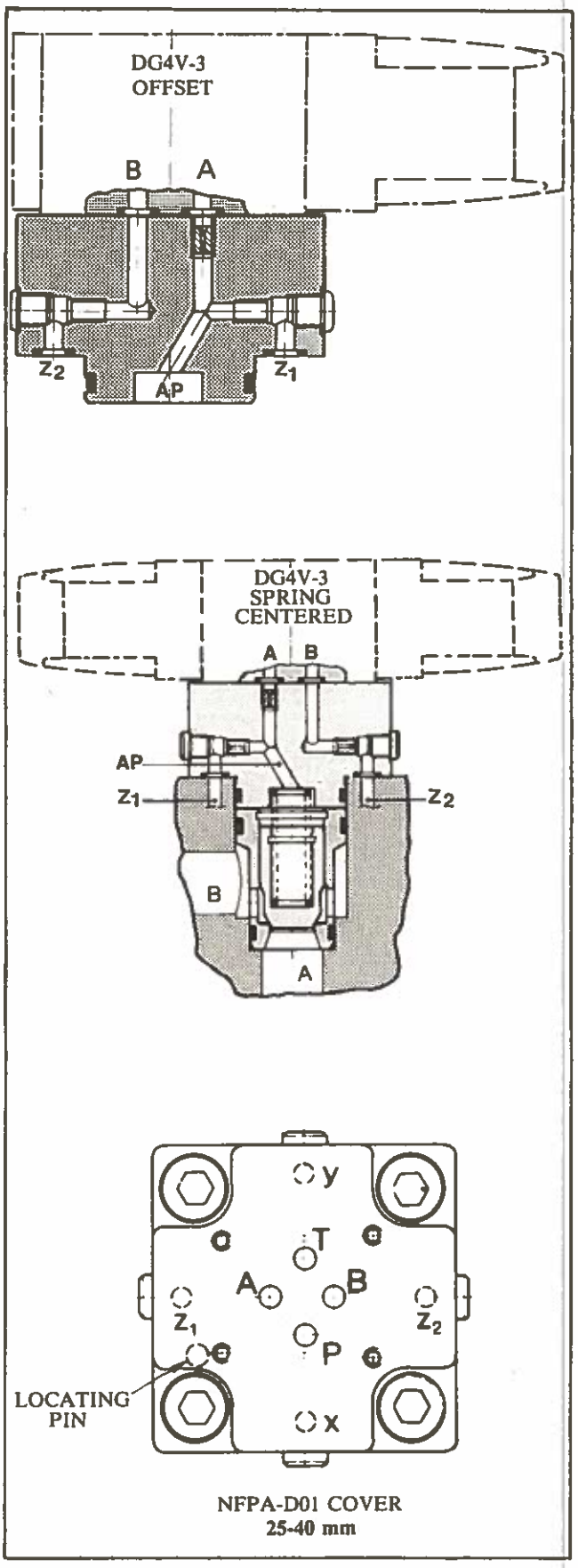


Figure 14. Directional Valves with NFPA-D01 Interface Pads

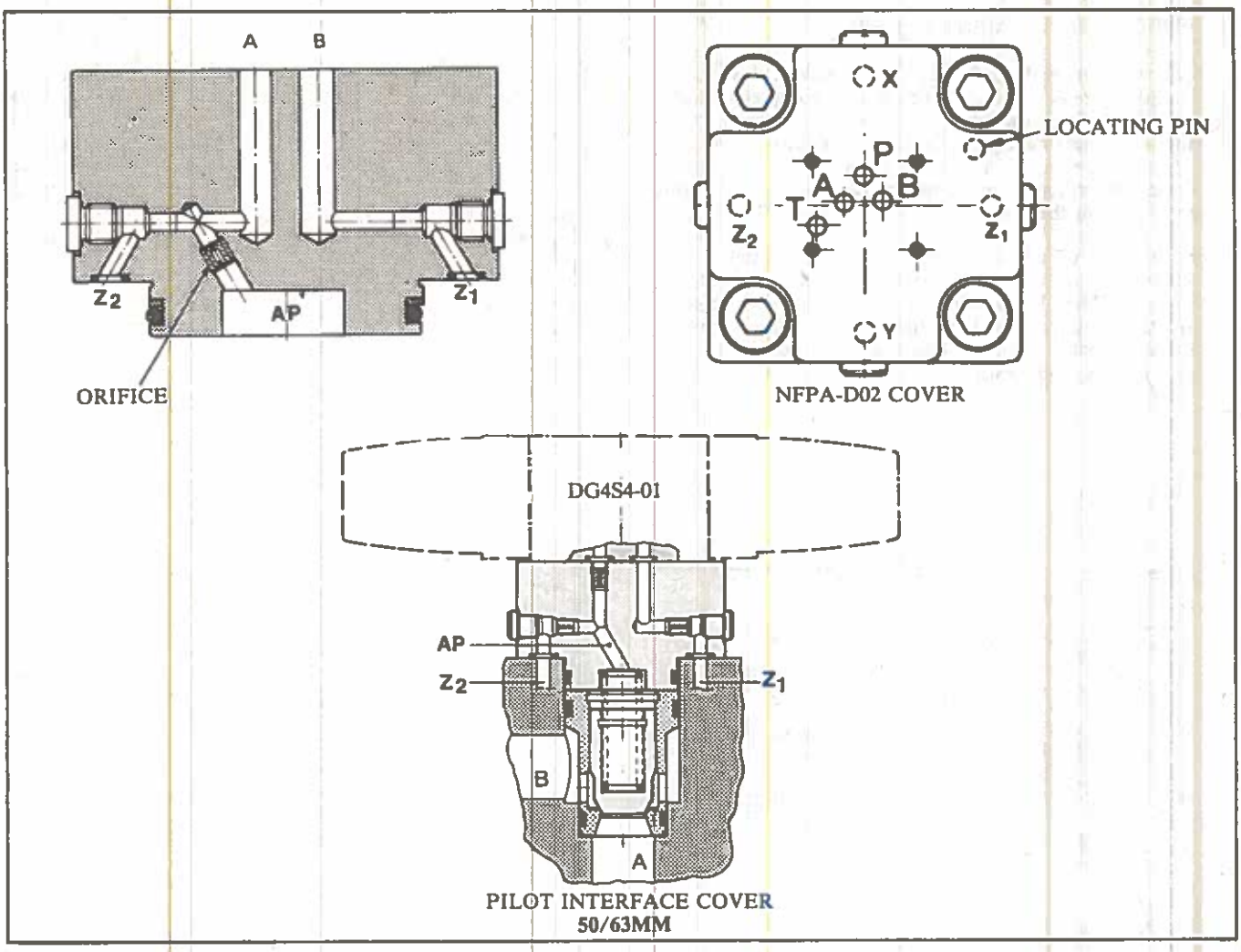


Figure 15. Directional Valves with NFPA-D02 Interface Pads

E. PILOT OPERATED CHECK COVER

The pilot operated check valve can be applied in much the same manner as other pilot operated checks available on the market. Three (3) pilot ports are used:

1. The 'X' port is drilled in the manifold to the pilot signal.
2. The 'Y' port is drilled in the manifold to connect with the 'B' port of the insert kit.
3. The 'Z1' port is normally connected to a drain line or tank port.

When there is no 'X' pilot signal to the valve, in effect we have a simple check valve. Flow can pass from 'A' to 'B' (if the pressure in the 'A' port is greater than the pressure in the 'B' port plus the spring force). Flow is blocked from 'B' to 'A' (see Figure 16).

When sufficient pilot pressure is applied to the 'X' port, the piston moves lifting the check valve ball from its seat. This drains pilot spring area 'AP'. If the 'A' port is pressurized, flow will pass from 'A' to 'B' (all area ratios). If 'B' port is pressurized, flow will pass from 'B' to 'A' providing the area ratio is 1:1.1 or 1:2. The pilot piston has an area 3.4 times the seat area of the check valve. This means that when system pressure is 3.4 times the pilot pressure, the pilot piston and ball are in pressure balance.

Make sure a pressure greater than one third (⅓) of system pressure is available for use as pilot pressure. The pilot pressure may go as high as 5000 PSIG.

F. SHUTTLE VALVE COVERS (Standard)

A shuttle valve cover is a device which will take the higher of two pilot pressures and direct it to pilot spring area 'AP'. A schematic diagram of the shuttle valve is shown in Figure 17. The 'X' pilot port and the 'Y' pilot port feed fluid to each end of the shuttle. The spring chamber (port 'AP') is connected to the center section of the shuttle. The 'Z2' port is also connected to the center section of the shuttle.

(A sectional view of the shuttle cover is shown in Figure 18.)

A seat is pressed into the cover bore and a ball is inserted. The outer plug is then threaded into the cover. The outer plug contains the ball/seat that is located between pilot (spring) area 'AP' and the 'Y' port. See schematic diagram Figure 17. An "O" ring and back-up ring located on the plug, prevents leakage between the 'AP' and 'Y' port areas; another "O" ring prevents external leakage.

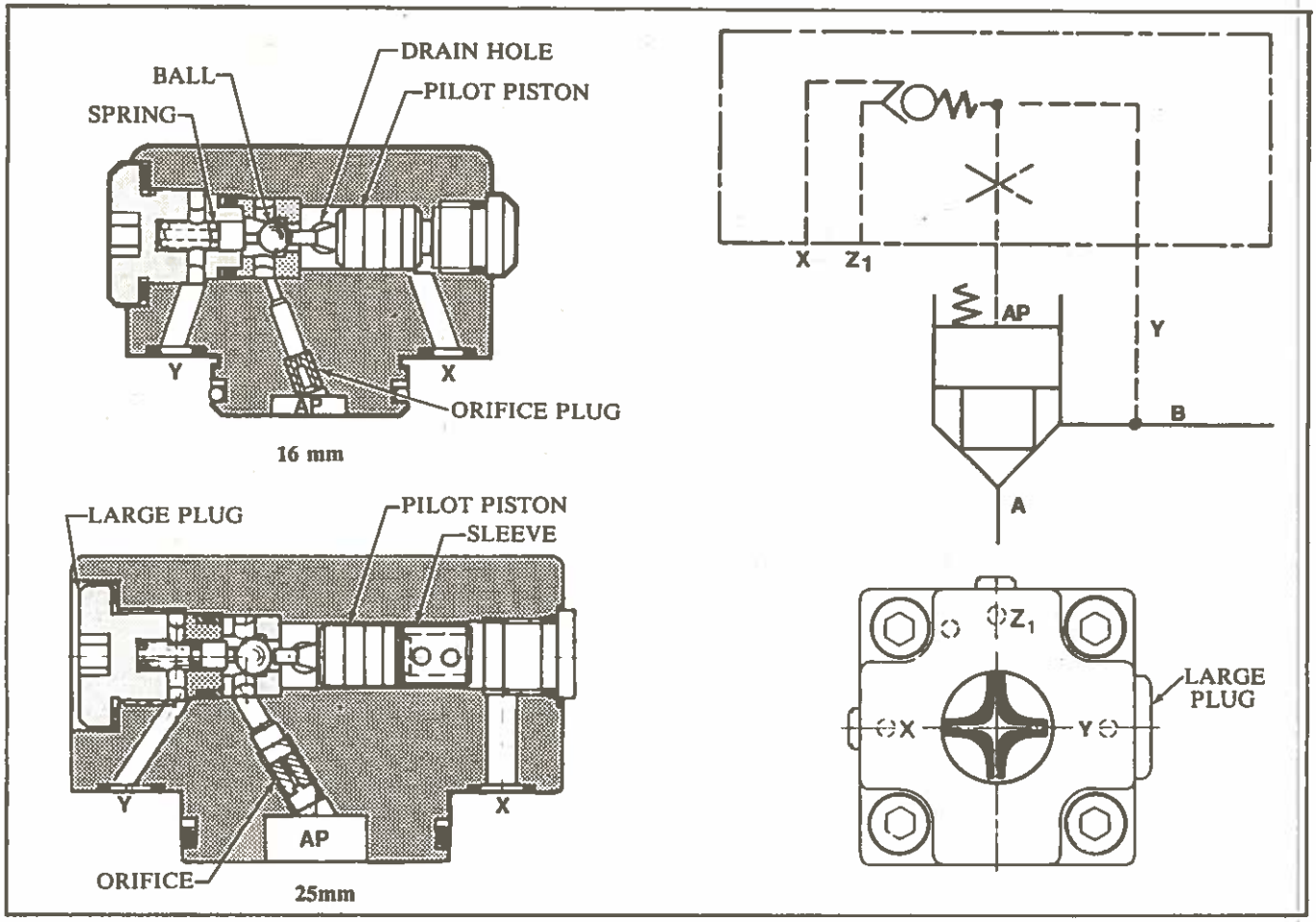


Figure 16. 'X' Part Pressure to Zero (0). Operate as a Standard Check Valve.

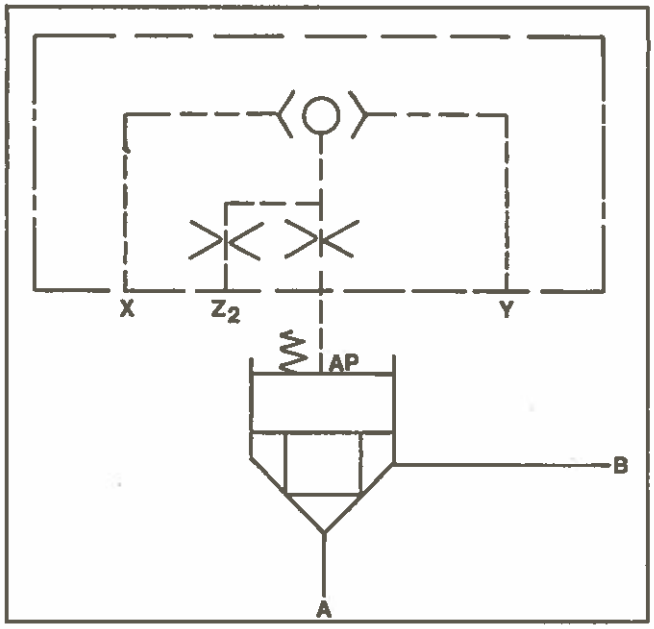


Figure 17. Shuttle Valve Schematic Diagram

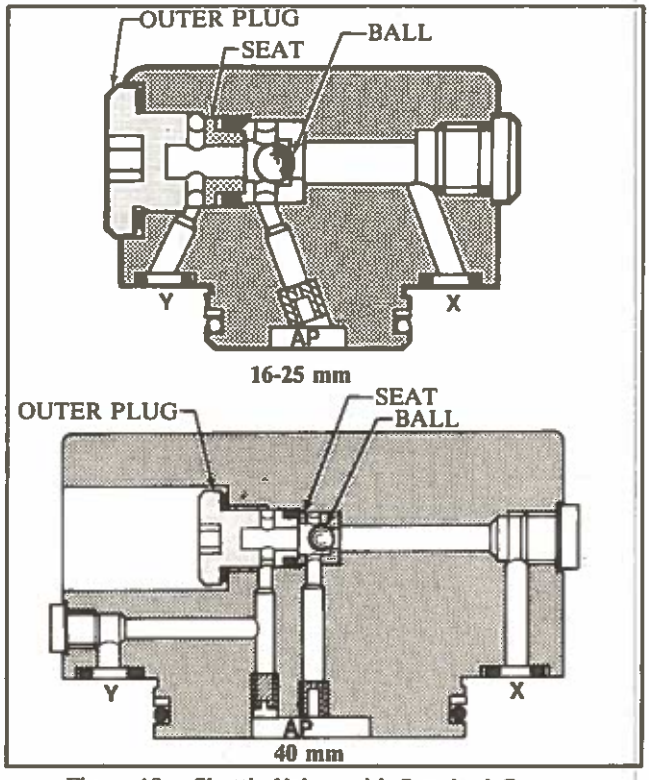


Figure 18. Shuttle Valves with Standard Covers

G. SHUTTLE VALVE COVERS WITH NFPA-D01 AND NFPA-D02 INTERFACES

A shuttle valve with a directional valve connected to the NFPA-D0* interface expands a basic check valve to a check/on/off device. A (1:2 ratio) circuit using this configuration is shown in Figure 19. The circuit operates as follows:

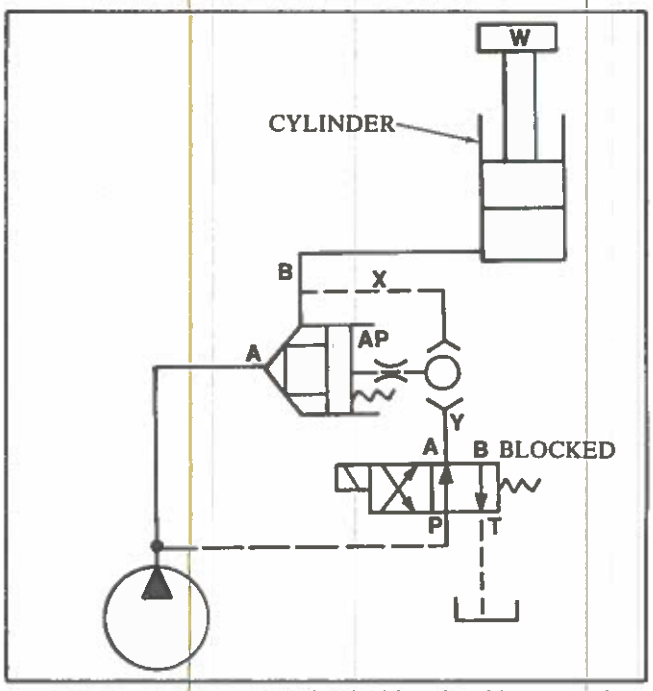


Figure 19. No Flow Permitted with Solenoid De-energize

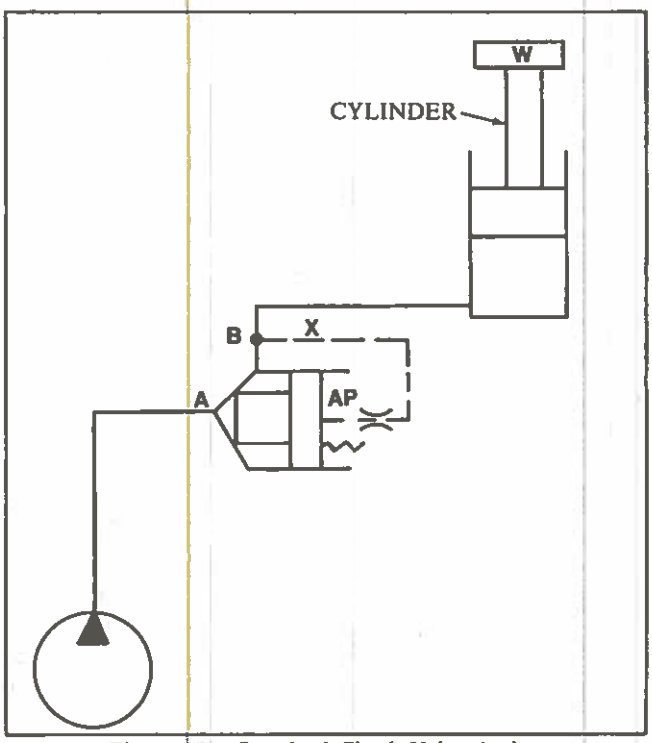


Figure 20. Standard Check Valve Action with Solenoid Energized

When the solenoid is de-energized, the highest pressure in port 'X' or 'Y' is transmitted through the shuttle valve to pilot area 'AP'. This means the valve is closed, If 'A' and 'B' were at equal pressures, the spring force would keep the valve closed. At any other pressure condition of 'A' or 'B', the highest pressure will be applied to the pilot area (AP) of the spool and a hydraulic closing force plus the spring force will keep the spool closed.

When the solenoid valve is energized, the pilot port labelled 'Y' is drained. Pressure from the 'B' port will keep the ball resting on the seat on the 'Y' port side of the shuttle valve. Flow from the pump is allowed to pass through the cartridge to the cylinder. Flow is blocked from the cylinder back to the pump. (Standard check valve action, see Figure 20.)

Shuttle covers are available in the 16, 25, and 40mm sizes. They are not available in the 50 and 63mm sizes. Two configurations of the shuttle valve are available (type 1 and type 2). The difference between the two is an assembly change which picks up the 'Z2' port from a different location in the cover (see Figures 21 and 22). The change from one assembly configuration to the other is made by exchanging the location of a solid plug and is not visible without removing external plugs from the cover. In some cases, the cover will have to be removed from the manifold to determine cover type.

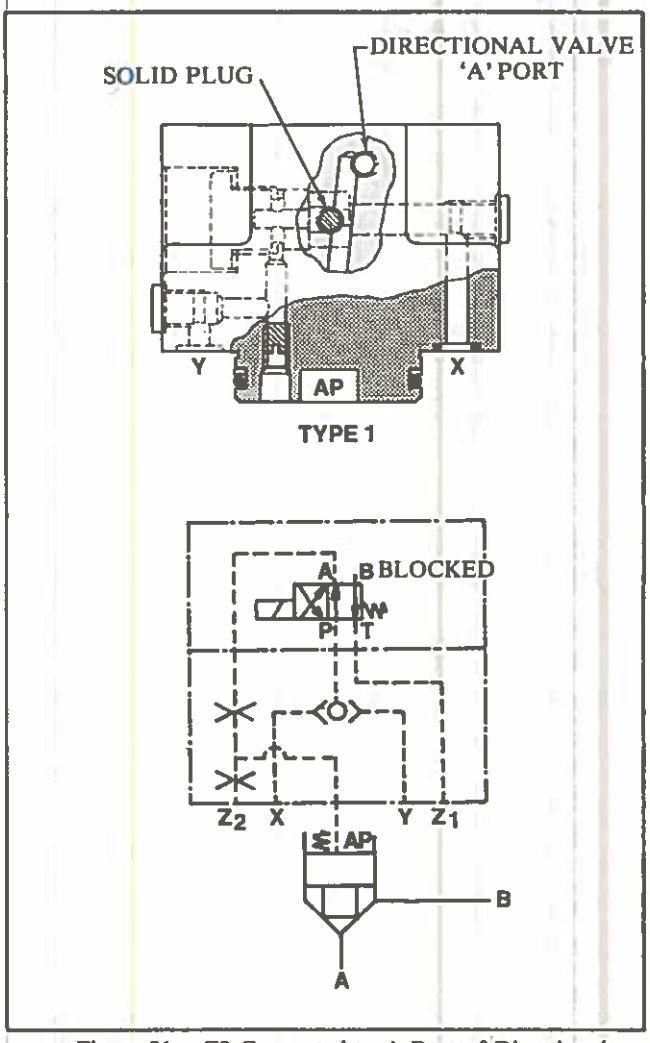


Figure 21. Z2 Connected to A Port of Directional Valve and to 'AP' Pilot Spring Chamber

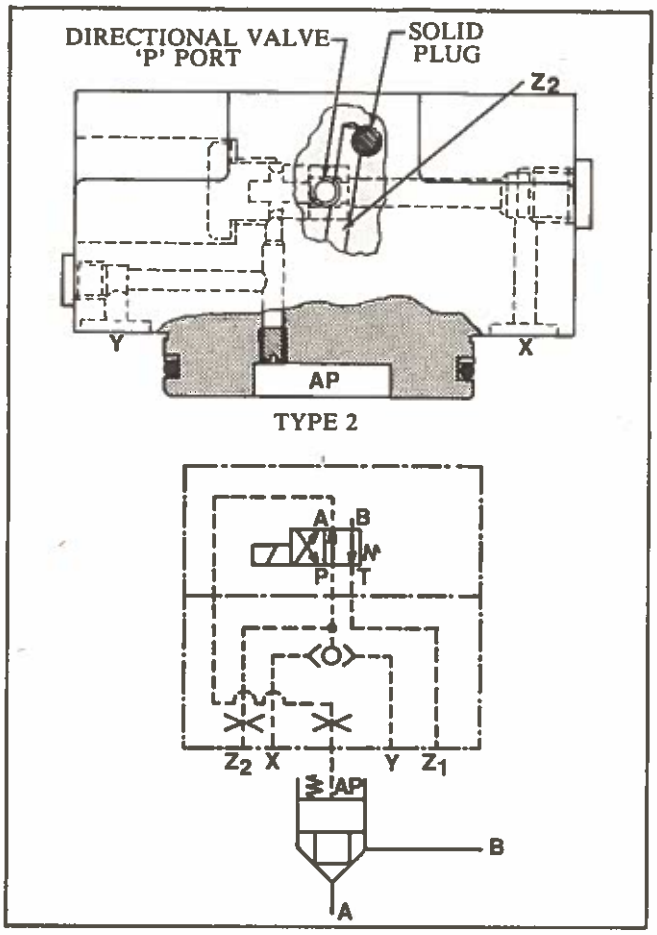


Figure 22. Z2 Connected to 'P' Port of Directional Valve

H. CARTRIDGE VALVE INSERT KIT

A basic cartridge valve insert kit consists of a sleeve, spring and spool. The cartridge valve insert kit has three major areas called 'A' port, 'B' port and 'AP' pilot port. The 'A' port area is the circular area defined by the seat inside diameter. The 'B' port area is the annular area between the seat ID and the outside diameter of the spool. The 'X' port is connected to the pilot spring area 'AP' which is the circular area defined by the diameter of the spool. Pressure on the 'AP' area plus spring force hold the spool against the seat. Pressure on the 'A' and 'B' areas tend to lift the spool off the seat allowing flow through the valve. See Figure 23 for a sectional view of the 'A', 'B', and 'AP' areas.

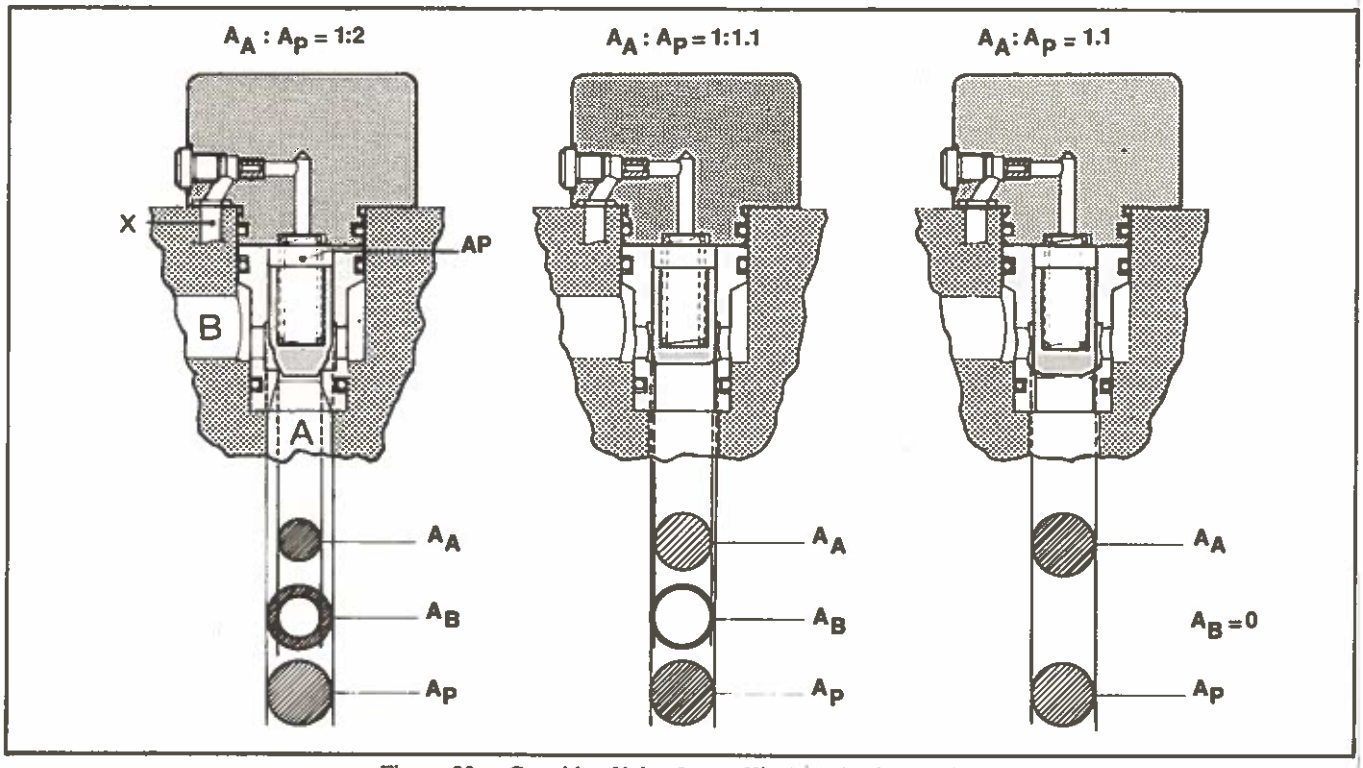


Figure 23. Cartridge Valve Insert Kit Area Ratios Defined

A. INSTALLATION DRAWINGS - The installation drawings listed in Table 1 show installation dimensions and port locations.

B. MOUNTING - Cartridge valves are designed to be installed into manifolds with most circuit connections within the manifold. This minimizes external circuit connections and provides a very compact package. Each cartridge valve installation is unique for a specific application. Many valve functions can be included within the manifold.

C. PIPING AND TUBING - If a cartridge valve manifold is actuator mounted, only pressure and tank lines will be required. All pipes and tubing must be throughly cleaned along with the passages within the manifold. Recommended methods of cleaning are sandblasting, wire brushing, pickling and power flushing.

NOTE
For instruction on pickling, refer to instruction sheet 1221-S.

1 . To minimize flow resistance and possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

2 . The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

D. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components. Any oil selected for use with valves must also be acceptable for the system pumping source and actuator.

Data sheet I-286-S for oil selection is available from Sperry Vickers Technical Publications, Troy, Michigan.

Oil recommendations noted in the data sheet is based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Sperry Vickers representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminants into the system.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

5. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over emphasized.

6. Thorough precaution should be taken, by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is important in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similiar to cavitation.

E. OVERLOAD PROTECTION

Relief valves limit pressure in the system to a prescribed maximum and protect components from excessive pressure. The setting of the relief valve depends on the work requirements of the system components.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Sperry Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutions may result in early failure.

G. TROUBLESHOOTING

By applying the basic operating principles discussed up to this point a technician can in a relatively short time become proficient in the troubleshooting of cartridge valve circuits. Basically, the cartridge valve is a check valve and the pilot valve controls the various pressures and forces that open or close the check.

Section V · SERVICE AND MAINTENANCE

A. SERVICE TOOLS

STANDARD TOOLS

1. Torque wrench with hex bit adapter sockets. (Refer to unit being repaired and use appropriate torque wrench.)

SIZE/mm	TORQUE	
	N.m	lb. ft.
16	35	25.8
25	110	81.0
40	500	368.0
50	580	428.0
63	1200	885.0

Table 8. Torque Wrench Size

2. Set of U.S. and metric hex key wrenches
3. Set of small pin punches
4. 3/8" ratchet with sockets
5. Small ball peen hammer
6. 25.4 mm (1 inch) micrometer
7. Metric ruler

SPECIAL TOOLS - No special tools required.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin the pump and other system components. If bubbles are seen, locate the source of the air and seal the leak.

5. A unit which is running excessively hot or noisy is a potential failure. Should a unit become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the hydraulic unit. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

The only adjustment provided is a unit that has stroke adjustment capability. Stroke adjusters will limit the poppet travel and react as an uncompensated flow regulator in the circuit. Directional valves using the stroke adjustment feature can be tuned to the desired response through the use of the stroke adjuster. Adjustment of the fixed orifices used within the system will probably not be required since the system is tuned and the orifices determined during the system design phase.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of external adjusters will not be required.

Section VI · OVERHAUL

WARNING

Before breaking a circuit connection, make sure that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

CAUTION

Absolute cleanliness is essential when working on a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Discard and replace all "O" rings, gaskets and back-up rings removed during disassembly.

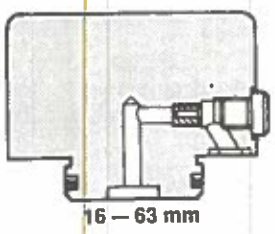
A. STANDARD COVERS

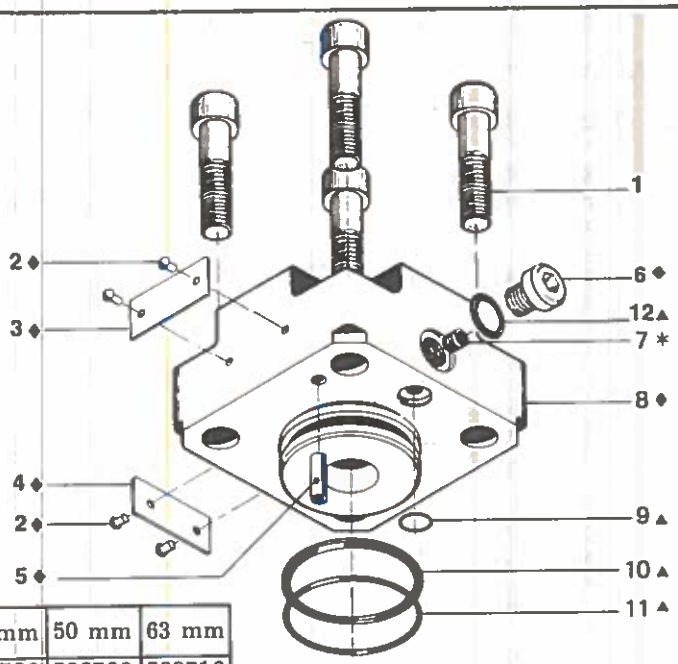
Disassemble and assemble the standard covers according to item number sequence. No special procedures are required for this type cover. See Figure 24 for exploded view of the cover and associated part numbers.

B. COVERS WITH STROKE ADJUSTMENT

Disassemble and assemble covers with stroke adjustment according to item number sequence (see Figure 25). Special procedures are required for disassembly and assembly of the micrometer knob units. Refer to Figure 26 and the associated assembly/disassembly procedures if the micrometer knob requires repair.

Standard Covers





ITEM NO.	PART DESCRIPTION	16 mm	25 mm	40 mm	50 mm	63 mm
1	Bolt Kit (inch)	590700	590704	590706	590708	590710
	(metric)	590701	590705	590707	590709	590711
	Torque to (N. m)	(35)	(110)	(500)	(580)	(1200)
2 - 12	Cover Assembly	580006	580045	580085	589120	589143
◆2	Screw (2 Req'd)	46351	46351	46351	46351	46351
◆3	Nameplate	———	———	———	168958	168958
◆4	Nameplate	168958	168598	168598	———	———
◆5	Rollpin	161236	226797	226797	195940	195940
◆6	Plug	398071	398071	398071	315932	315932
	Torque to (N. m)	(10)	(10)	(10)	(30)	(30)
* 7	Standard Orifice	761623	761166	762863	813806	764969
◆8	Cover	580013	580056	580094	589106	589129
▲9	"O" Ring	200082	200083	200085	200085	200103
▲10	Back-Up Ring	271732	271787	271801	271863	271873
▲11	"O" Ring	179347	154026	154086	154040	154049
▲12	"O" Ring	154124	154124	154124	154128	154128

▲ INCLUDED IN SEAL KIT. SEE TABLE 16 FOR KIT NUMBERS

◆ NOT AVAILABLE FOR SALE

* FOR OTHER SIZES OF ORIFICE SEE TABLE 9.

Figure 24. Standard Cover Parts

ORIFICE KIT → ORIFICE SIZE (mm)	FOR VALVE SIZE 16 mm	25/40 mm	50/63 mm
	761006	761061	764101
0.5	761621	761062	———
0.6	763343	763731	———
0.7	763344	763732	———
0.8	761622	761063	763719
0.9	———	763733	———
1.0	761623	761064	763720
1.1	763345	763734	———
1.2	761624	761166	763721
1.3	762859	762862	———
1.4	762860	762863	———
1.5	763220	763735	813775
1.6	———	———	813806
1.8	———	———	764969
2.3	763738	———	———
2.5	———	813744	———
3.0	———	———	813776
Plug (solid)	761620	761031	763718

Table 9. Orifice Kits

TORQUE CONVERSION FACTOR (APPROX)
lb. ft. = .74 x N. m
25.4 mm = 1 inch

Covers with Stroke Adjustment

ITEM NO	PART DESCRIPTION	VALVE SIZE	WITH ADJUSTING KNOB	WITH ADJ KNOB & KEYLOCK	WITH ADJUSTING ROD & CAP	WITH ADJUSTING ROD
2 - 24	COVER WITH STROKE ADJUSTMENT S/A	16 mm	580007	580008	580009	——
		25 mm	580046	580047	580053	
		40 mm	——	——	——	580086
		50 mm				589121
		63 mm				589144

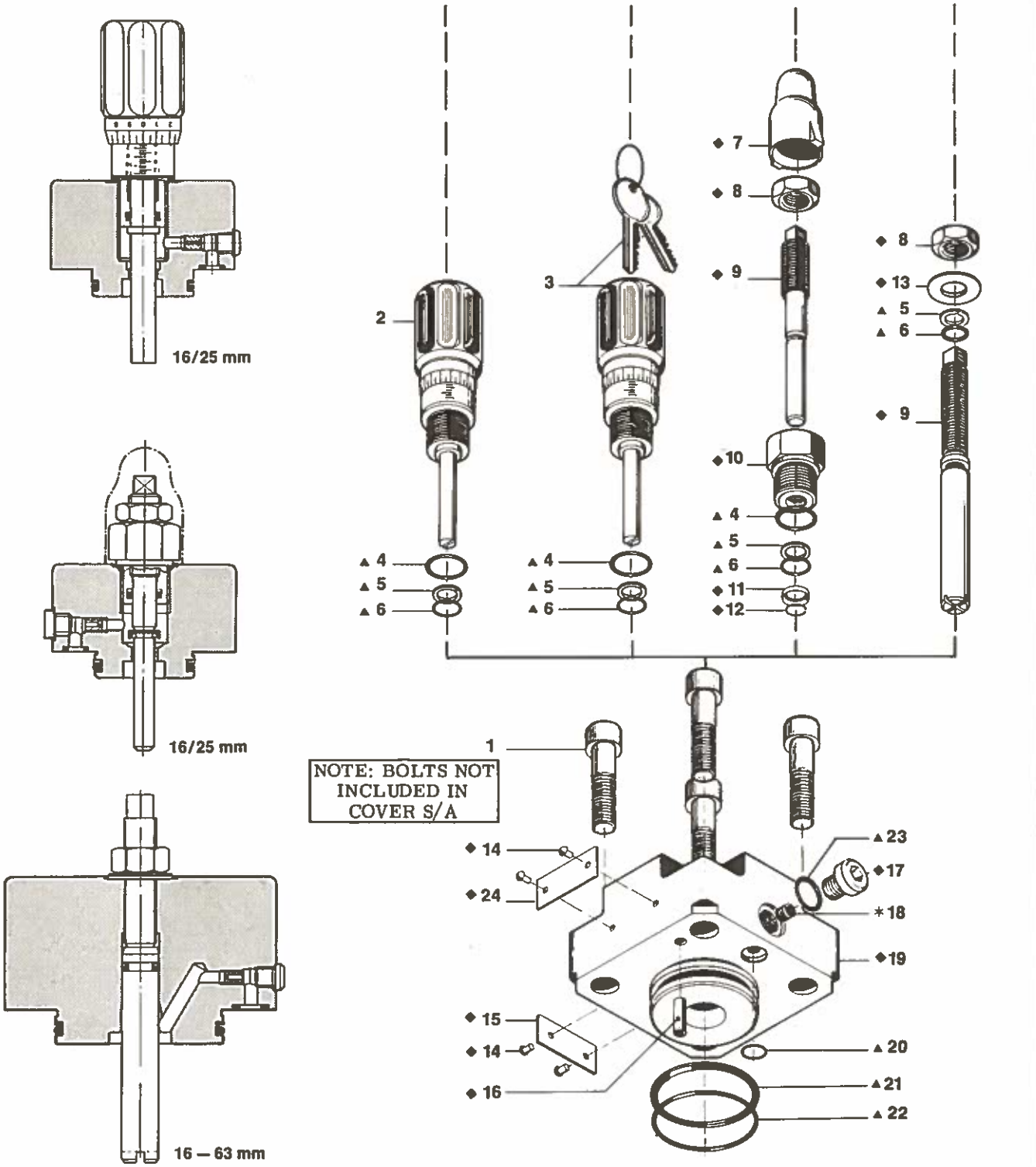


Figure 25. Covers with Stroke Adjustment

Stroke Adjustment Parts

ITEM NO	PART DESCRIPTION	SIZE				
		16 mm	25 mm	40 mm	50 mm	63 mm
1	BOLT KIT (inch)	590700	590704	590706	590708	590710
	(metric)	590701	590705	590707	590709	590711
	Torque to (N. m)	(35)	(110)	(500)	(580)	(1200)
■ 2	KNOB S/A	764615	764617	——	——	——
■ 3	KNOB with KEYLOCK S/A	764616	764618	——	——	——
▲ 4	"O" RING	154013	154013	——	——	——
▲ 5	BACK-UP RING	197588	197588	197588	197628	197630
▲ 6	"O" RING	154008	154008	154008	154015	154017
◆ 7	CAP	762607	762607	——	——	——
◆ 8	LOCKNUT	761190	761190	761190	763770	763727
◆ 9	ADJUSTING ROD	764458	764459	579926	589151	589152
◆10	ADAPTER	579922	579922	——	——	——
	Torque to (N. m)	(100)	(100)	——	——	——
◆11	RETAINING RING	762488	762488	——	——	——
◆12	CIRCLIP	762487	762487	——	——	——
◆13	WASHER	——	——	761192	763690	763726

Cover Parts

ITEM NO	PART DESCRIPTION	SIZE				
		16 mm	25 mm	40 mm	50 mm	63 mm
◆14	SCREW (2 REQ'D)	46351	46351	46351	46351	46351
◆15	NAMEPLATE	168958	168958	168958	——	——
◆16	ROLLPIN	161236	226797	226797	195940	195940
◆17	PLUG	398071	398071	398071	315932	315932
	Torque to (N. m)	(10)	(10)	(10)	(30)	(30)
*18	STANDARD ORIFICE	761623	761166	762863	813806	764969
◆19	COVER	580014	580057	580095	589108	589131
▲20	"O" RING	200082	200083	200085	200085	200103
▲21	BACK-UP RING	271732	271787	271801	271863	271873
▲22	"O" RING	179347	154026	154086	154040	154049
▲23	"O" RING	154124	154124	154124	154128	154128
◆24	NAMEPLATE	——	——	——	168958	168958

Figure 25. Parts Information

▲ INCLUDED IN SEAL KIT. SEE TABLE 16 FOR KIT NUMBERS.

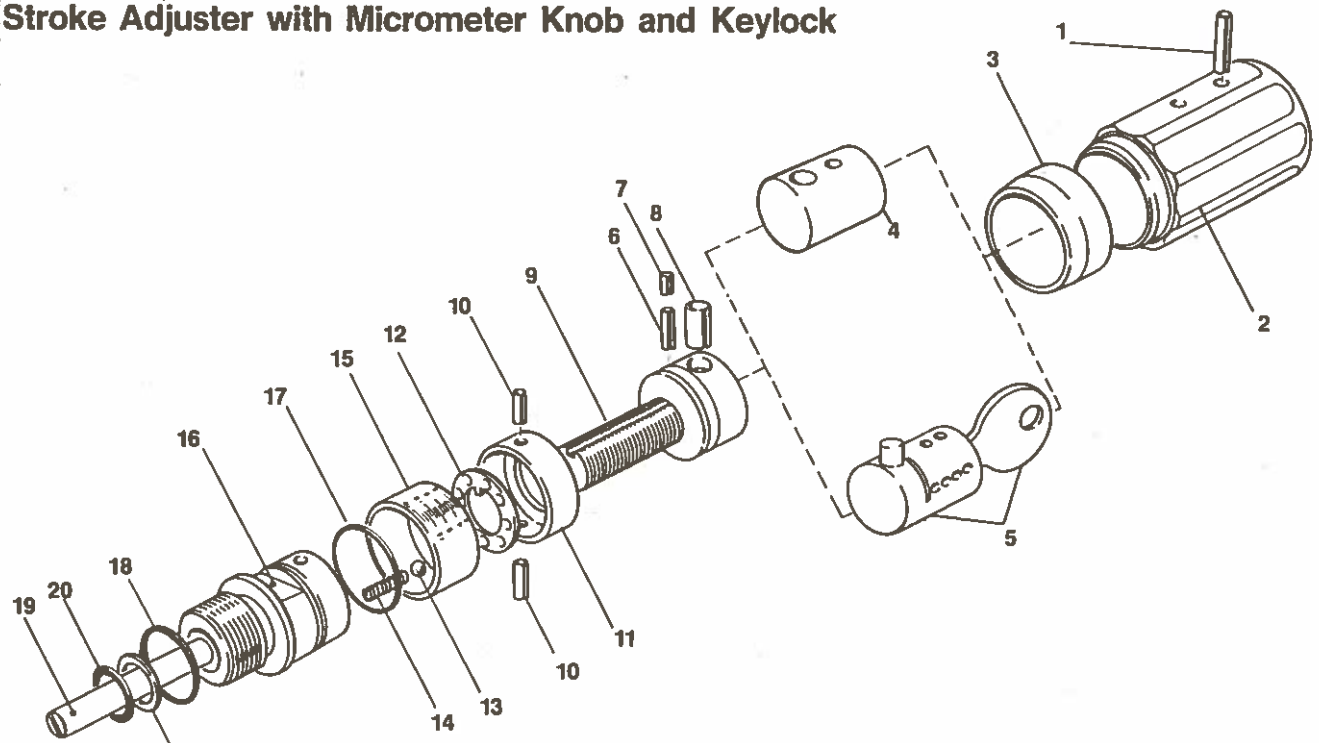
■ KITS - STROKE ADJUSTERS WITH KNOB OR WITH KNOB AND KEYLOCK. KNOB ASSEMBLY & DISASSEMBLY PROCEDURES SHOWN ON FOLLOWING PAGE.

TORQUE CONVERSION FACTOR (APPROXIMATELY) lb. ft. = .74 x N. m

◆ NOT AVAILABLE FOR SALE

* FOR OTHER SIZES OF ORIFICE SEE TABLE 9. ORIFICES ARE AVAILABLE ONLY AS PART OF AN ORIFICE KIT.

Stroke Adjuster with Micrometer Knob and
Stroke Adjuster with Micrometer Knob and Keylock



ITEM	DESCRIPTION	ITEM	DESCRIPTION
◆ 1	ROLLPIN	◆ 12	RATCHET PLATE
◆ 2	KNOB	◆ 13	BALL
◆ 3	SCALE RING	◆ 14	SPRING
◆ 4	BOLT	◆ 15	SCALE
◆ 5	KEY LOCK	◆ 16	ADAPTER
◆ 6	ROLLPIN	▲● 17	"O" RING
◆ 7	ROLLPIN	▲● 18	"O" RING
◆ 8	ROLLPIN	◆ 19	ADJUSTING PIN
◆ 9	ADJUSTING ROD	▲● 20	"O" RING
◆10	ROLLPIN	▲● 21	BACK-UP RING
◆11	RETAINING RING		

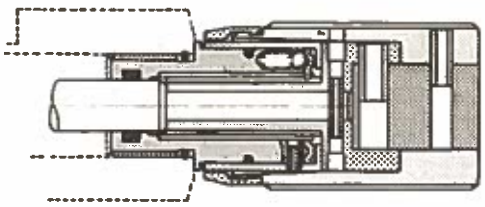
Figure 26. Exploded View

◆ INDIVIDUAL ITEMS ARE NOT AVAILABLE AS SPARE PARTS, BUT ARE CONTAINED IN KITS. REFER TO FIGURE 25.

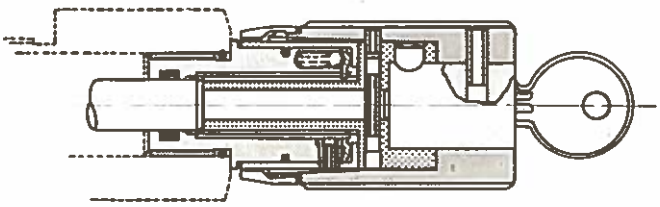
▲ INCLUDED IN SEAL KITS. SEE TABLE 16 FOR KIT NUMBERS.

● MICROMETER KNOB AND KEYLOCK SEAL KIT NO. 920232

F3 EQUIVALENT SEAL KIT NO. 920233



Stroke Adjuster with Micrometer Knob



Stroke Adjuster with Micrometer Knob and Keylock

DISASSEMBLY PROCEDURE FOR MICROMETER KNOB TYPE STROKE ADJUSTER (Refer to Figure 26)

1. Push rollpin (1) into bolt (4).

2. Pull adjuster knob (2) and scale ring (3) from assembly to expose adjustment rod (9) and bolt (4).

3. Push rollpin (6) through adjustment rod (9) and thread adjustment rod and bolt counterclockwise from adapter (16). Press rollpin (1) through bolt. Retain rollpins (1 & 6) for assembly.

4. Push two rollpins (10) into adapter (16) just enough to remove retaining ring (11). Remove retaining ring, ratchet plate (12), ball (13), spring (14) and scale (15).

5. Thread adapter (16) from cover and remove 'O' rings (14) and (18). Discard the 'O' rings.

6. Press two rollpins (10) through adapter (16) into the center threaded area and remove. Retain the rollpins for assembly.

7. Slide adjusting pin (19) from adapter (16).

8. Remove 'O' ring (20) and back-up ring (21) from within adapter (16) and discard.

ASSEMBLY PROCEDURE FOR MICROMETER KNOB TYPE STROKE ADJUSTER (Refer to Figure 26)

1. Obtain a seal kit and install back-up ring (21) and 'O' ring (20) within adapter (16). Lubricate seals with system fluid.

2. Insert adjusting pin (19) into adapter (16).

3. Install 'O' rings (18) and (17) on adapter (16) and thread in place within the cover. Torque to 100 N.m (73 lb. ft.).

4. Install scale (15) in place over 'O' ring (17). Make sure scale is oriented correctly.

5. Lubricate spring (14), ball (13) and ratchet plate (12) with petroleum jelly and install in place. Place retaining ring (11) over the ratchet plate and align rollpin holes. Insert rollpins (10) flush with outside surface of retaining ring. DO NOT press past flush or the adjuster will bind.

6. Lubricate and thread adjustment rod (9) and bolt clockwise into adapter (16). Make sure tang of ratchet plate is in alignment with groove of adjustment rod. Thread adjustment rod in until rollpin hole of adjusting pin is in alignment with hole in the adjustment rod. Install rollpin (6) into hole and center as shown in Figure 26 sectional view. Move the adjustment rod, the adjusting pin should rotate. This verifies correct alignment.

7. Install knob (2) and scale ring (3) as an assembly over bolt (4). Hold adjusting pin (19) and align rollpin hole (1) with opening in bolt (4). Install rollpin (1) flush with outside of knob (2).

DISASSEMBLY PROCEDURE FOR MICROMETER KNOB WITH KEYLOCK TYPE STROKE ADJUSTER (Refer to Figure 26)

1. Unlock adjuster knob (2) with key (5) and rotate knob to engage detent, less than one turn.

2. Push rollpin (7) into adjustment rod (9).

3. Lock adjuster knob (2) and remove key (5). Pull adjuster knob (2), scale ring (3), and keylock (5) from assembly to expose adjustment rod (9).

4. Push rollpins (6 and 7) through adjustment rod (9), then thread adjustment rod (9) counterclockwise from adapter (16).

5. Push two rollpins (10) into adapter (16) just enough to remove retaining ring (11). Remove retaining ring, ratchet plate (12), ball (13), spring (14) and scale (15).

6. Thread adapter (16) from cover and remove 'O' rings (17 and 18). Discard the 'O' rings.

7. Press two rollpins (10) through adapter (16) into the center threaded area and remove. Retain the rollpins for assembly.

8. Slide adjusting pin (19) from adapter (16).

9. Remove 'O' ring (20) and back-up ring (21) from within adapter (16) and discard.

ASSEMBLY PROCEDURE FOR MICROMETER KNOB WITH KEYLOCK TYPE STROKE ADJUSTER (Refer to Figure 26)

1. Obtain a seal kit and install back-up ring (21) and 'O' ring (20) within adapter (16). Lubricate seals with system fluid.

2. Insert adjusting pin (19) into adapter (16).

3. Install 'O' ring (18 and 17) on adapter (16) and thread in place within the cover. Torque to 100 N.m (73 lb. ft.).

4. Install scale (15) in place over 'O' ring (17). Make sure scale is oriented correctly.

5. Lubricate spring (14), ball (13) and ratchet plate (12) with petroleum jelly and install in place. Place retaining ring (11) over the ratchet plate and align rollpin holes. Insert rollpins (10) flush with outside surface of retaining ring. DO NOT press rollpins (10) past flush or the adjuster will bind.

6. Lubricate and thread adjustment rod (9) into adapter (16). Make sure tang of ratchet plate is in alignment with groove of adjustment rod. Thread adjustment rod in until rollpin hole of adjusting pin is in alignment with hole in adjustment rod. Install rollpin (6) into hole and center as shown in Figure 26 sectional view. Move the adjustment rod, the adjusting pin should rotate. This verifies correct alignment.

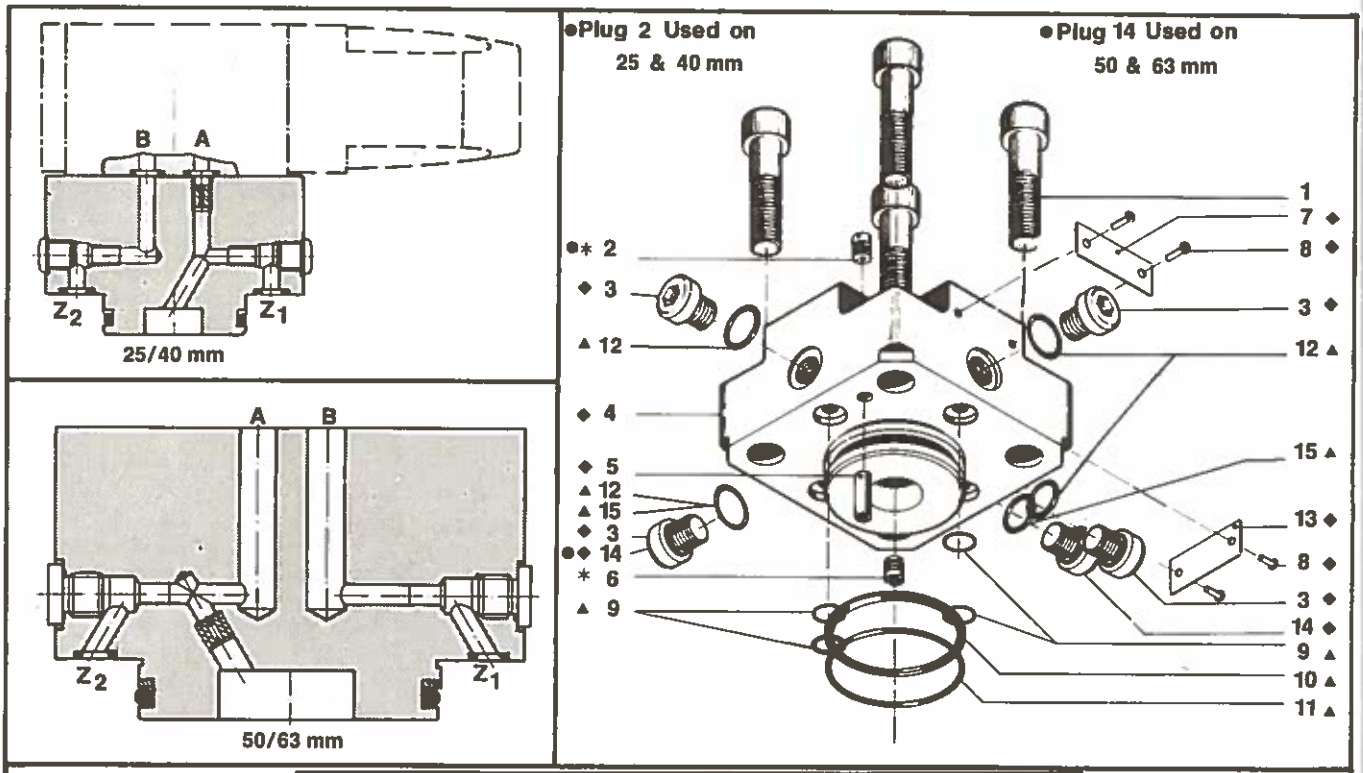
7. Lock the keylock located within knob (2). Install knob (2) with keylock (5) and scale ring (3) over adjusting rod (9). Turn key to unlock and rotate knob until detent locks in place within the adjusting rod (less than one full turn). Install rollpin (7) in place flush with outside of knob (2). DO NOT press past flush or knob may bind. Lock knob, the knob should rotate freely in the locked condition.

C. COVERS WITH PILOT VALVE INTERFACE

Disassemble cover according to item number sequence shown in Figure 27.

NOTE

Refer to parts drawings shown in Table 10 for pilot valve information.



ITEM NO.	COVER PARTS PART DESCRIPTION	VALVE SIZE IN (mm) COVERS WITH (ISO-4401-3)/ NFPA-D01 INTERFACE 25 mm	40 mm	COVERS WITH (ISO-4401-5)/ NFPA-D02 INTERFACE 50 mm	63 mm
1	BOLT (inch)	590704	590706	590708	590710
	KIT (metric)	590705	590707	590709	590711
	Torque to (N. m)	(110)	(500)	(580)	(1200)
2 - 15	COVER ASSEMBLY	580048	580088	589122	589145
* 2	STD. ORIFICE	761166	762863	———	———
◆ 3	PLUG	398071	398071	315932	315932
	Torque to	(4 REQ'D) (10 N. m)		(3 REQ'D) (30 N. m)	
◆ 4	COVER	580058	580096	589107	589130
◆ 5	ROLLPIN	226797	226797	195940	195940
* 6	STD. ORIFICE	———	———	813806	764969
◆ 7	NAMEPLATE	———	168958	168958	168958
◆ 8	SCREW (2 REQ'D)	46351	46351	46351	46351
▲ 9	"O" RING (4 REQ'D)	200083	200085	200085	200103
▲10	BACK-UP RING	271787	271801	271863	271873
▲11	"O" RING	154026	154086	154040	154049
▲12	"O" RING	154124 (4 REQ'D)	154124	154128 (3 REQ'D)	154128
◆13	NAMEPLATE	168958	———	———	———
◆14	PLUG (2 REQ'D)	———	———	343740	343740
	Torque to (N. m)	———	———	(15)	(15)
▲15	"O" RING (2 REQ'D)	———	———	154126	154126

Figure 27. Covers with NFPA-D01(ISO-4401-3)/NFPA-D02(ISO-4401-5) Interface

◆ NOT AVAILABLE FOR SALE

* FOR OTHER SIZES OF ORIFICES SEE TABLE 9.

▲ INCLUDED IN SEAL KIT. SEE TABLE 16 FOR KIT NUMBERS.

TORQUE CONVERSION FACTOR (APPROXIMATELY) lb. ft. = .74 x N. m

NFPA-D01	
MODEL	PARTS DWG.
DG4V-3-A/B/C-10	I-3529-S
DG4V-3-N-11	I-3529-S
DG4V-3-A-12	I-3629-S
DG4V-3-B/C-12	I-3630-S
DG4V-3-N-12	I-3631-S

NFPA-D02	
MODEL	PARTS DWG.
DG4S4-01*A-W-10	I-3557-S
DG4S4-01*B/C-W-10	I-3558-S
DG4S4-01*N-W-10	I-3559-S
DG4S4-01*A-50	I-3478-S
DG4S4-01*C-50	I-3477-S
DG4S4-01*N-51	I-3471-S

Table 10. Pilot Valve Information

D. COVERS WITH PILOT OPERATED CHECK VALVES

NOTE

Refer to Figure 28 during the disassembly and assembly instruction that follow.

DISASSEMBLY

Remove parts in numerical sequence as shown on Figure 28. (Note: DO NOT remove plug (9) from cover (5).) Discard all seals. Obtain a new seal kit prior to assembly. See Table 16 for seal kit numbers.

ASSEMBLY

CAUTION

Assembly of check valve parts (14 through 21) is difficult so be sure to follow instruction carefully. The ball and spool can fall out of position and jam during installation. DO NOT force plug (21) at assembly.

1. Lubricate internal parts with clean hydraulic fluid.

2. Install seals (18, 19 and 20) on plug (21).

3. Secure cover (5) into a vise with cover bore that accommodates parts (14 through 21) facing up.

4. Install seat (14) into cover (5) as shown. Gently tap seat into place with a suitable nylon or brass rod.

5. Apply a heavy amount of petroleum jelly or equivalent on ball (15). Install the ball into seat (14).

6. Reverse cover position (180°) in the vise so cover bore faces down. Make sure the ball stays in place inside the seat.

7. Install spring (17) and spool (16) into plug (21).

8. Carefully insert plug (21) into cover bore. Thread plug into cover about three full turns.

9. Obtain a small pin and insert into the opposite bore and apply pressure against ball (15). Push on the pin to compress spring (17) and at the same time thread plug (21) into cover (5). Do not force plug if it seems to bind before reaching its full engagement. The spool (16) can fall out of position and may bind the plug.

10. Compress and decompress the spring (17) with the pin to verify proper operation after assembly. When the pin is removed, the ball must rest against seat (14). Final torque plug (21) as noted in the parts tabulation of Figure 28.

11. Insert pilot spool (24) into cover as shown. Install spacer (23) into cover on 25 and 40 mm models only.

12. Assemble seal (25) on plug (22). Install plug into cover and torque as noted in parts tabulation.

13. Assemble remaining parts (13 through 2) in reverse order of disassembly. Be sure to torque plug (4) as noted in the parts table, Figure 28.

E. COVERS WITH SHUTTLE VALVES

NOTE

Disassemble according to item number sequence shown in Figure 29. Assemble according to reverse item number sequence. Lubricate all parts with system fluid at assembly. Torque all plugs and bolts as noted in parts tabulation of Figure 29.

CAUTION

DO NOT attempt removal of plug (10). The plug is bonded in position and must not be removed.

F. COVERS WITH SHUTTLE VALVE AND PILOT VALVE INTERFACE

NOTE

Disassemble according to item number sequence shown in Figure 30. Assemble according to reverse item number sequence. Lubricate all parts with system fluid at assembly. Torque all plugs and bolts as noted in parts tabulation of Figure 30.

CAUTION

DO NOT attempt removal of plugs (7 or 8). The plugs are bonded in position and must not be removed.

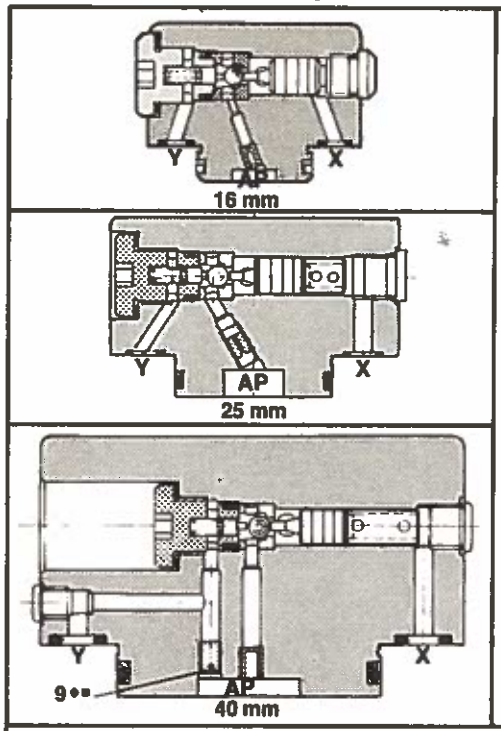
NOTE

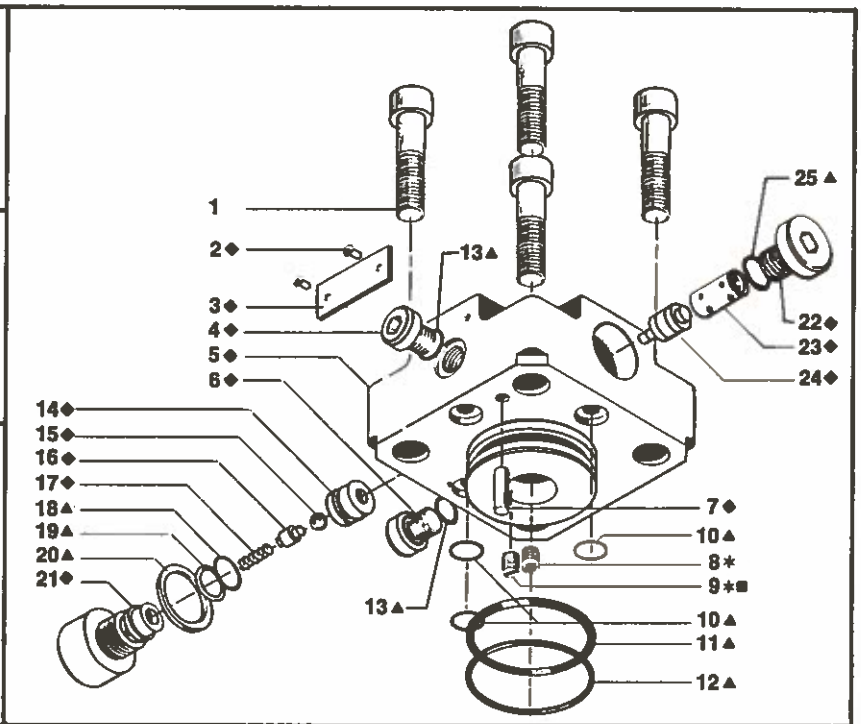
Refer to parts drawings shown in Table 11 for pilot valve information.

NFPA-D01 (ISO-4401-3) Interface	
MODEL	PARTS DWG.
DG4V-3-A/B/C-10	I-3529-S
DG4V-3-N-11	I-3529-S
DG4V-3-A-12	I-3629-S
DG4V-3-B/C-12	I-3630-S
DG4V-3-N-12	I-3631-S

Table 11. Pilot Valve Information

Covers with Pilot Operated Check Valve





COVER PARTS

ITEM NO.	PART DESCRIPTION	16 mm	25 mm	40 mm
1	BOLT KIT (inch)	590700	590704	590706
	(metric)	590701	590705	590707
	Torque to (N. m)	(35)	(110)	(500)
2 - 25	COVER ASSEMBLY	580011	580052	580087
◆ 2	SCREW (2 REQ'D)	46351	46351	46351
◆ 3	NAMEPLATE	168958	168958	168958
◆ 4	PLUG	398071	398071	398071
	Torque to (N. m)	(10)	(10)	(10)
◆ 5	COVER	580017	580061	580099
◆ 6	PLUG	———	———	398071
	Torque to (N. m)	———	———	(10)
◆ 7	ROLLPIN	161236	226797	226797
∗ 8	STANDARD ORIFICE	761623	761166	762863
∗■ 9	PLUG	———	———	761031
▲ 10	"O" RING (3 REQ'D)	200082	200083	200085
▲ 11	BACK-UP RING	271732	271787	271801
▲ 12	"O" RING	179347	154026	154086
▲ 13	"O" RING	154124	154124	154124
	(Quantity)	(1)	(1)	(2)

CHECK VALVE PARTS

16, 25, & 40 mm SIZES

ITEM NO.	PART DESCRIPTION	PART NO.
◆ 14	SEAT	760882
◆ 15	BALL	1651
◆ 16	SPOOL	760889
◆ 17	SPRING	580042
▲ 18	"O" RING	154139
▲ 19	BACK-UP RING	580550
▲ 20	UST RING	760934
◆ 21	PLUG	760881
	Torque to (N. m)	(150)
◆ 22	PLUG	315932
◆ 23	SPACER (16 mm)	———
	SPACER (25 mm)	760843
	SPACER (40 mm)	761506
◆ 24	PILOT SPOOL	760928
▲ 25	"O" RING	154128

◆ NOT AVAILABLE FOR SALE

∗ FOR OTHER SIZES OF ORIFICE SEE TABLE 9. ORIFICES AVAILABLE ONLY AS PART OF AN ORIFICE KIT.

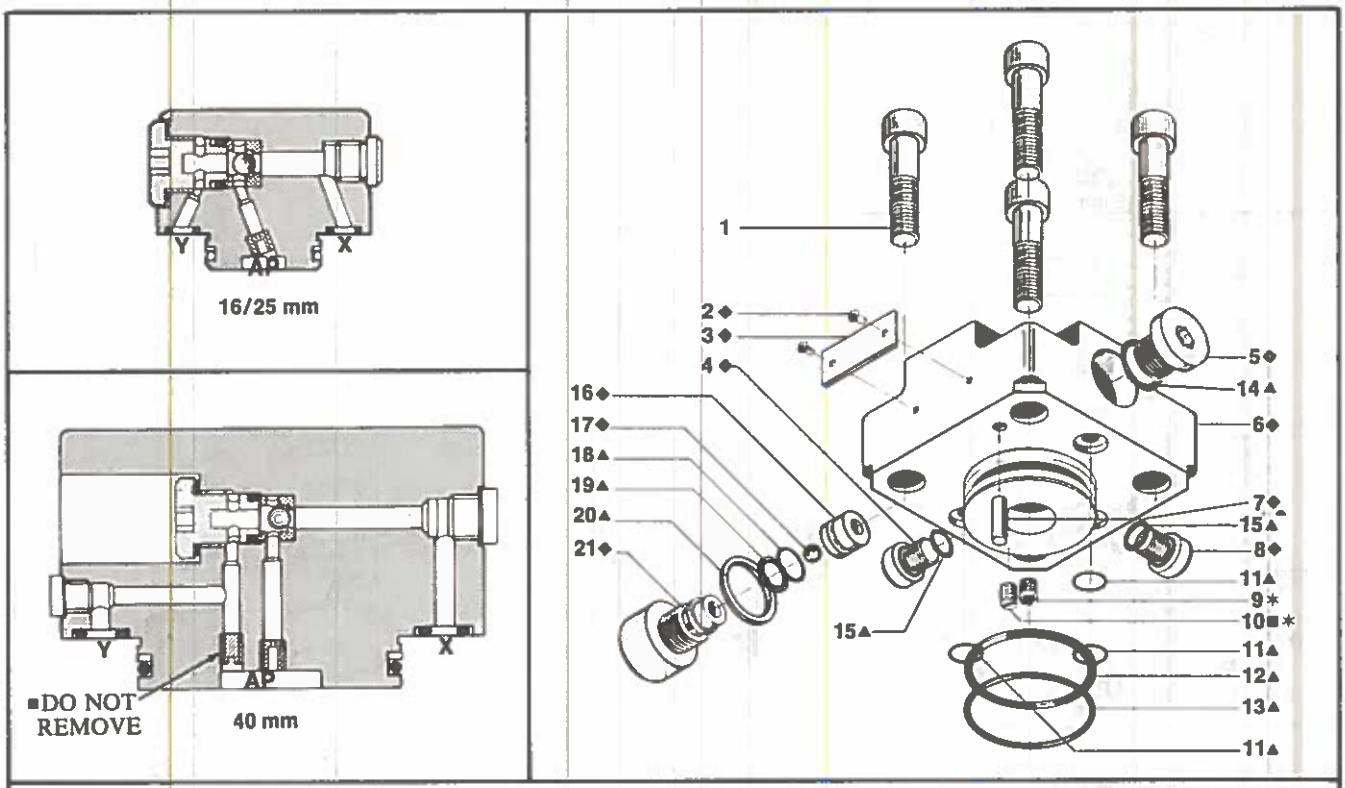
▲ INCLUDED IN SEAL KIT. SEE TABLE 16 FOR KIT NUMBERS.

TORQUE CONVERSION FACTOR (APPROXIMATELY) lb. ft. = .74 x N. m

■ THIS PLUG IS BONDED WITH A SPECIAL COMPOUND. IT IS NOT TO BE REMOVED.

Figure 28. Covers with Pilot Operated Check Valve

Covers with Shuttle Valves



COVER PARTS

ITEM NO.	PART DESCRIPTION	16 mm	25 mm	40 mm
1	BOLT KIT (inch)	590700	590704	590706
	(metric)	590701	590705	590707
	Torque to (N. m)	(35)	(110)	(500)
2 - 20	COVER ASSEMBLY	580010	580049	580089
◆ 2	SCREW (2 REQ'D)	46351	46351	46351
◆ 3	NAMEPLATE	168958	168958	168958
◆ 4	PLUG	———	———	398071
	Torque to (N. m)	—	—	(10)
◆ 5	PLUG	315932	315932	315932
	Torque to (N. m)	(30)	(30)	(30)
◆ 6	COVER	580016	580060	580098
◆ 7	ROLLPIN	161236	226797	226797
◆ 8	PLUG	398071	398071	398071
	Torque to (N. m)	(10)	(10)	(10)
* 9	STANDARD ORIFICE	761623	761166	762863
*■10	PLUG	———	———	761031
▲ 11	"O" RING (3 REQ'D)	200082	200083	200085
▲ 12	BACK-UP RING	271732	271787	271801
▲ 13	"O" RING	179347	154026	154086
▲ 14	"O" RING	154128	154128	154128
▲ 15	"O" RING (1 or 2 REQ'D)	154124 (1)	154124 (1)	154124 (2)

SHUTTLE VALVE PARTS

16, 25, & 40 mm SIZES

ITEM NO.	PART DESCRIPTION	PART NO.
◆ 16	SEAT	760882
◆ 17	BALL	1651
▲ 18	"O" RING	154139
▲ 19	BACK-UP RING	580550
▲ 20	USIT RING	760934
◆ 21	PLUG	760881
	Torque to (N. m)	(150)

◆ NOT AVAILABLE FOR SALE

* FOR OTHER SIZES OF ORIFICE SEE TABLE 9. ORIFICES AVAILABLE ONLY AS PART OF A KIT.

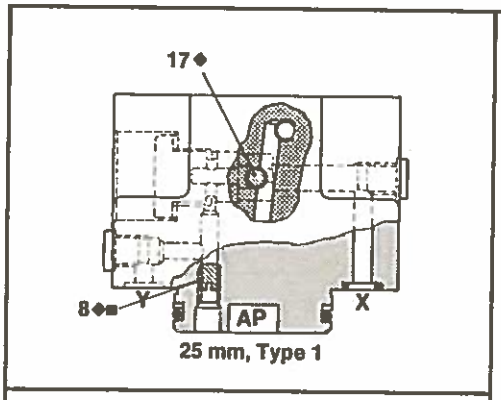
▲ INCLUDED IN SEAL KIT. SEE TABLE 16 FOR KIT NUMBERS.

TORQUE CONVERSION FACTOR (APPROXIMATELY) lb. ft. = .74 x N. m

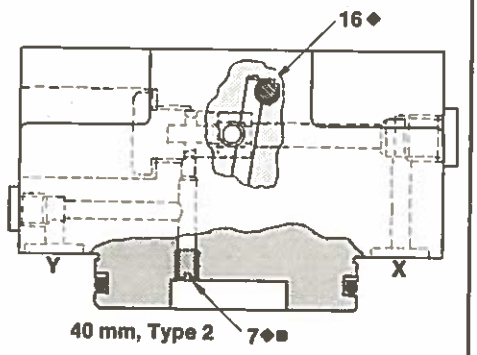
■ THIS PLUG IS BONDED WITH A SPECIAL COMPOUND. IT IS NOT TO BE REMOVED.

Figure 29. Covers with Shuttle Valves

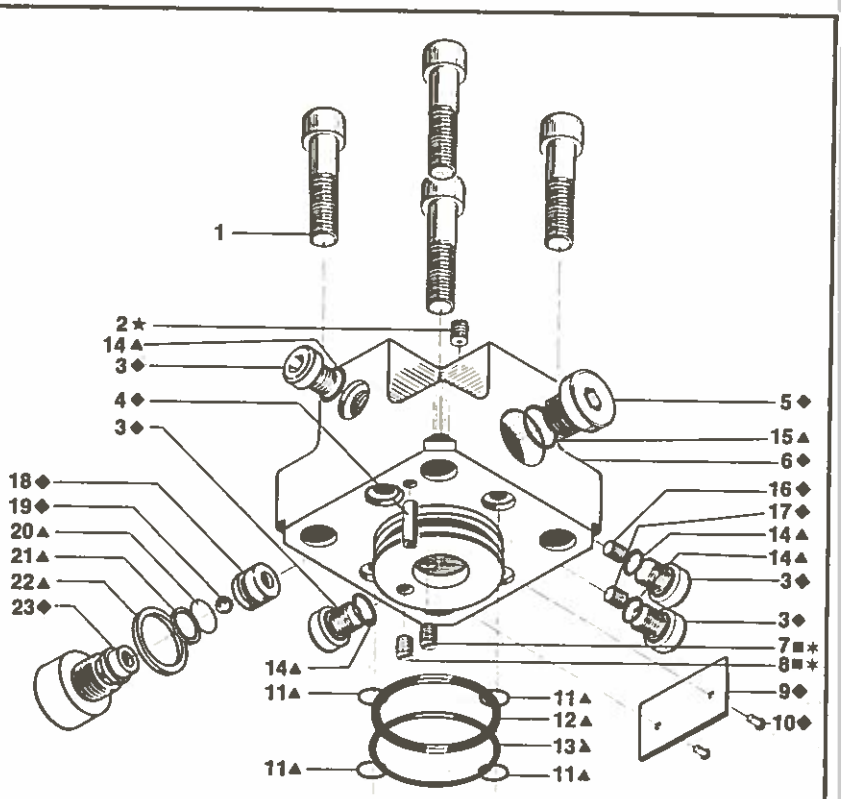
Covers with Shuttle Valve and NFPA-DO1 (ISO-4401-3) Interface



25 mm, Type 1



40 mm, Type 2



COVER PARTS

ITEM NO.	PART DESCRIPTION	25 mm	40 mm
1	BOLT KIT (inch)	590704	590706
	(metric)	590705	590707
	Torque to (N. m)	(110)	(500)
2 - 23	COVER ASSEMBLY TYPE 1	580050	580090
	TYPE 2	580051	580091
* 2	STANDARD ORIFICE	761166	762863
◆ 3	PLUG (4 REQ'D)	398071	398071
	Torque to (N. m)	(10)	(10)
◆ 4	ROLLPIN	226797	226797
◆ 5	PLUG	398071	315932
	Torque to (N. m)	(10)	(30)
◆ 6	COVER	580062	580100
*■7	PLUG	——	761031
*■8	PLUG	761031	——
◆ 9	NAMEPLATE	168958	168958
◆10	SCREW (2 REQ'D)	46351	46351
▲11	"O" RING (4 REQ'D)	200083	200085
▲12	BACK-UP RING	271787	281801
▲13	"O" RING	154026	154086
▲14	"O" RING (4 REQ'D)	154124	154124
▲15	"O" RING	154124	154128

■THIS PLUG IS BONDED WITH A SPECIAL COMPOUND. IT IS NOT TO BE REMOVED.

PLUGS FOR PILOT PASSAGES

25 & 40 SIZES

ITEM NO.	PART DESCRIPTION	COVER TYPE TYPE 1	COVER TYPE TYPE 2
◆16	UPPER PLUG	——	761031
◆17	CENTER PLUG	761031	——

SHUTTLE VALVE PARTS

25 & 40 mm SIZES

ITEM NO.	PART DESCRIPTION	PART NO.
◆18	SEAT	760882
◆19	BALL	.1651
▲20	"O" RING	154139
▲21	BACK-UP RING	580550
▲22	USIT RING	760934
◆23	PLUG	760881
	Torque to (N. m)	(150)

◆ NOT AVAILABLE FOR SALE

* FOR OTHER SIZES OF ORIFICES SEE TABLE 9. ORIFICES AVAILABLE ONLY AS PART OF A KIT.

▲ INCLUDED IN SEAL KIT. SEE TABLE 16 FOR KIT NUMBERS.

TORQUE CONVERSION FACTOR (APPROXIMATELY) lb. ft. = .74 x N. m

Figure 30. Covers with Shuttle Valve and NFPA-D01 (ISO-4401-3) Interface

G. DETERMINING CARTRIDGE VALVE INSERT KIT ASSEMBLY NUMBER

CAUTION

The assembly number stamped into the cover determines cover parts only. Each cover assembly can be used with up to thirteen (13) different cartridge valve insert kit assemblies. To determine the cartridge valve insert kit used in your valve, perform the following steps.

1. Determine cartridge valve metric size: Measure across the large diameter of the sleeve. See Table 12 for valve size.

SIZE (mm)	INCH	SIZE (mm)	INCH
16	1.260	50	3.543
25	1.771	63	4.724
40	2.952	—	—

Table 12. Valve Metric Size

2. After size of the valve is determined, refer to the cartridge insert exploded view Figure 31 and sectional views Figure 32. There are five different cartridge insert configurations to choose from. Compare your parts to the ones shown. This will give you the "TYPE" and "AREA RATIO".

3. Measure the spring (3) wire diameter with a micrometer to determine the spring number. Refer to Table 13.

MODEL	SPRING	WIRE (Dia. In.)
16 mm	580039	0.040
	580040	0.059
	580041	0.072
25 mm	580080	0.062
	580081	0.080
	580082	0.110
40 mm	579944	0.098
	579945	0.112
	579946	0.135
50 mm	589125	0.135
	589126	0.177
	589127	0.218
63 mm	589148	0.177
	589149	0.244
	589150	0.273

Table 13. Determining Spring (3) Type (See Figure 31)

4. With valve metric size, area ratio and spring number, determine cracking pressure (A to B) from spring, Table 14.

5. With valve metric size, area ratio and cracking pressure, determine kit assembly number from cartridge insert kit, Table 15.

Spool and Sleeve

ITEM NO	DESCRIPTION		POPPET TYPE & AREA RATIO				
			1:1 STD.	1:1.1 STD.	1:2 STD.	1:2 WITH METERING	1:1.1 ORIFICE TYPE (with std. orifice)
◆1	SPOOL	16 mm	762927	760970	760971	760974	761910
		25 mm	762990	760856	760857	760858	761911
		40 mm	763056	760892	761894	760896	761912
		50 mm	———	763671	763672	763673	———
		63 mm		763709	763710	763711	
◆2	SLEEVE	16 mm	579983	580037	580038	580038	580037
		25 mm	580267	580078	580079	580079	580078
		40 mm	580328	579942	579943	579943	579942
		50 mm	———	589101	589102	589102	———
		63 mm		589103	589104	589104	

◆NOT AVAILABLE FOR SALE (ORDER INSERT KIT)

▲INCLUDED IN SEAL KIT (SEE TABLE 16 FOR KIT NUMBERS)

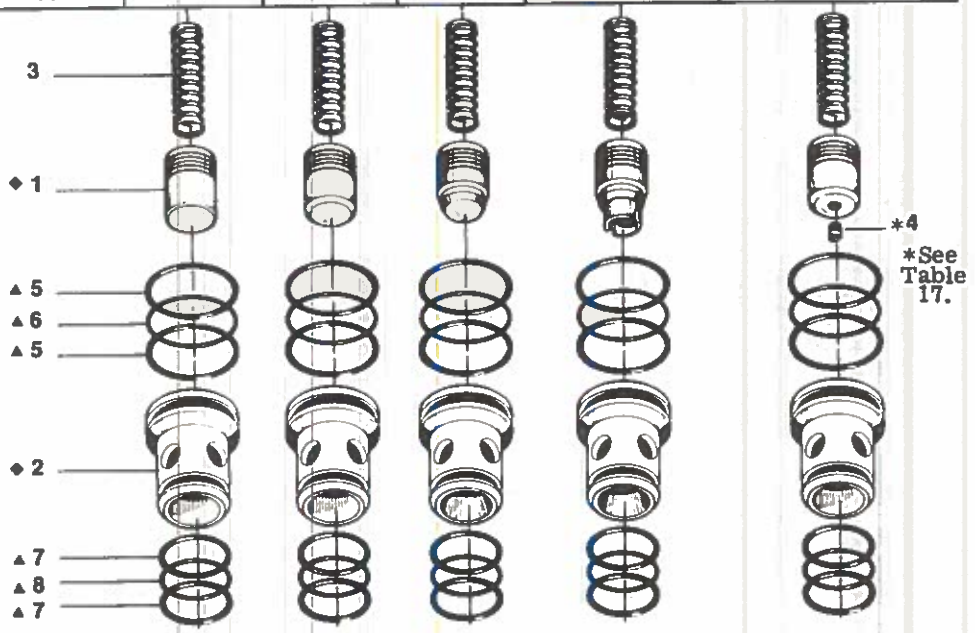


Figure 31. Exploded View of Main Stage Cartridge Showing Spool and Sleeves

ITEM NO.	VALVE SERIES	AREA RATIO A_A:A_P CRACKING PRESSURE A→B						
		1:1	1:1.1			1:2		
		2.0 bar	0.3 bar	1.5 bar	2.7 bar	0.5 bar	2.5 bar	5.0 bar
3 (Figure 31)	16 mm	580041	580039	580040	580041	580039	580040	580041
	25 mm	580082	580080	580081	580082	580080	580081	580082
	40 mm	580329	579944	579945	579946	579944	579945	579946
	50 mm	——	589125	589126	589127	589125	589126	589127
	63 mm		589148	589149	589150	589148	589149	589150

Table 14. Cracking Pressures ('A' to 'B' Flow)

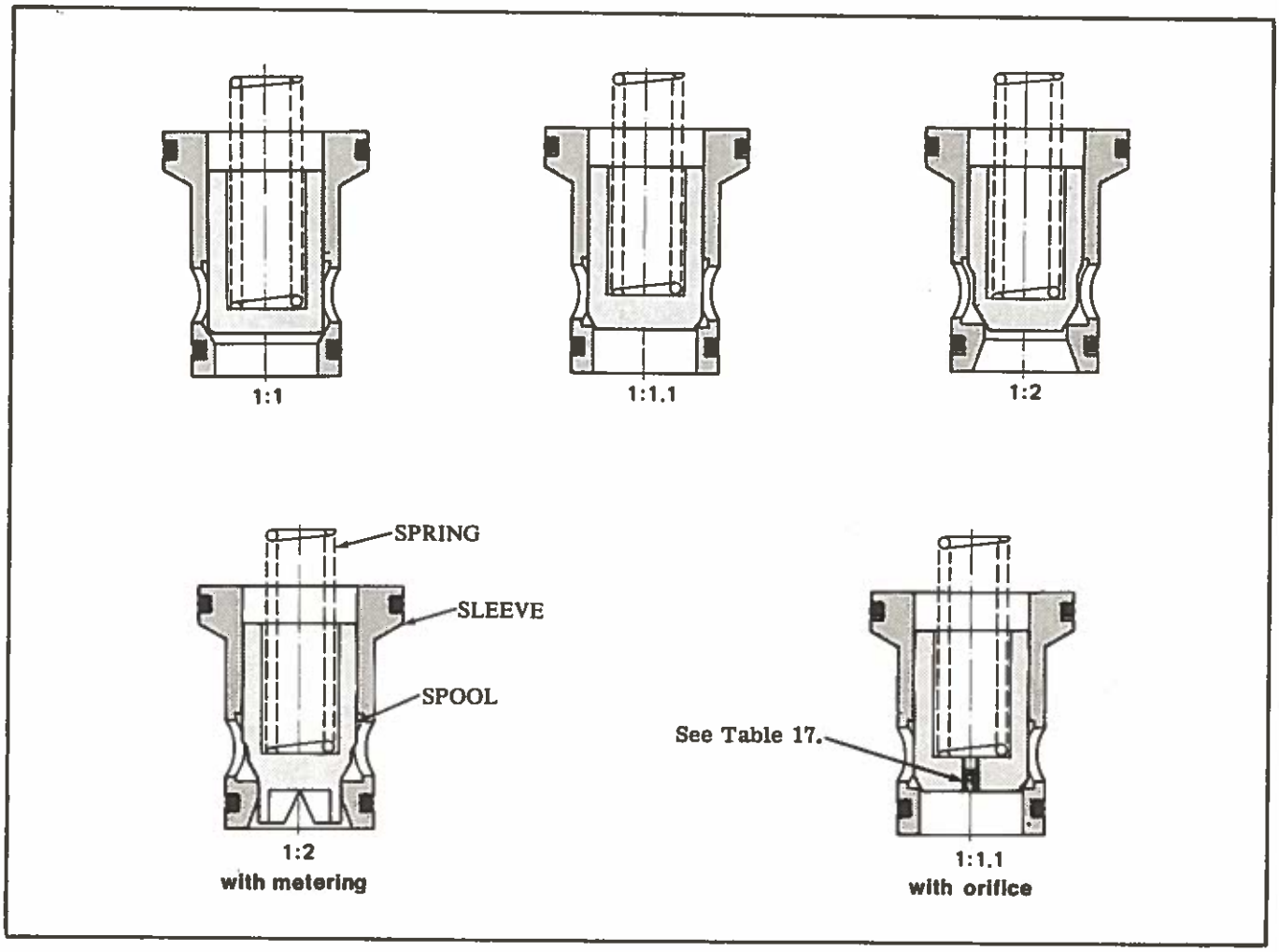


Figure 32. Sectional View of Main Stage Cartridge Kit

Cartridge Insert Kits (REFER TO SECTIONAL VIEW FIGURE 32.)

AREA RATIO A_A:A_P	CRACKING PRESSURE bar A→B	CRACKING PRESSURE bar B→A	SIZE 16 mm	SIZE 25 mm	SIZE 40 mm	SIZE 50 mm	SIZE 63 mm
STANDARD							
1:1	2.0	—	579976	580259	580321	—	—
1:1.1	0.3	—	580019	580064	579929	589111	589134
1:1.1	1.5	—	580020	580065	579930	589112	589135
1:1.1	2.7	—	580021	580066	579931	589113	589136
1:2	0.5	0.5	580022	580067	579932	589114	589137
1:2	2.5	2.5	580023	580068	579933	589115	589138
1:2	5.0	5.0	580024	580069	579934	589116	589139
DAMPING (WITH METERING)							
1:2	0.5	0.5	580025	580070	579935	589117	589140
1:2	2.5	2.5	580026	580071	579936	589118	589141
1:2	5.0	5.0	580027	580072	579937	589119	589142
ORIFICE TYPE							
1:1.1	0.3	—	580028	580073	579938	—	—
1:1.1	1.5	—	580029	580074	579939		
1:1.1	2.7	—	580030	580075	579940		

NOTE: 1 bar = 14.5 PSI

Table 15. Tabulation of Main Valve Cartridge Kits

Seals/ Seal Kit Complete

ITEM NO.	DESCRIPTION	SIZE (mm) 16 mm	25 mm	40 mm	50 mm	63 mm
▲ 5	BACK-UP RING (2 REQ'D)	271732	271787	271801	271863	271873
▲ 6	"O" RING	179347	154026	154086	154040	154049
▲ 7	BACK-UP RING (2 REQ'D)	271728	271734	271790	271794	271863
▲ 8	"O" RING	199812	151733	154079	154083	154040
—	▲STANDARD SEAL KIT	920172	920174	920176	920207	920209
	F3 EQUIVALENT	920173	920175	920177	920208	920210

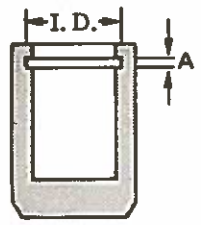
Table 16. Tabulation of Seal Kits. Refer o Figure 31. NOTE: Cover seals are included in the above seal kits.

Standard Orifice

ITEM NO.	ORIFICE SIZE (mm)	SIZE (mm) 16 mm	25/40 mm	50 mm	63 mm
* 4	1.2	761624	761166	—	—

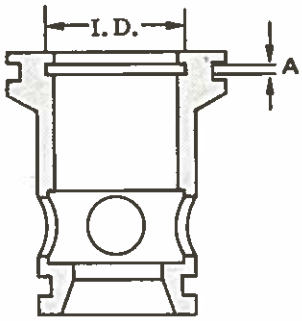
Table 17. Standard Spool Orifices

*Refer to Table 9 for Orifice Kit Information.



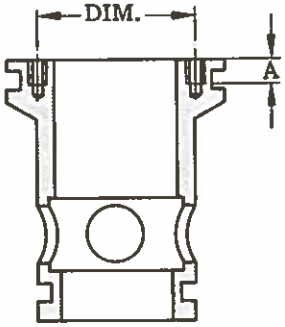
Removal of valve poppet from sleeve. This groove may be used to apply either an extractor or hooks.

VALVE SIZE	MEASUREMENTS			
	I. D.		A	
	(mm)	inches	(mm)	inches
16 mm	14. 0	0. 551	2. 0	0. 079
25 mm	19. 0	0. 748	2. 0	0. 0787
40 mm	32. 0	1. 259	2. 5	0. 0984
50 mm	45. 5	1. 791	4. 0	0. 1574
63 mm	53. 0	2. 086	4. 0	0. 1574



Removal of valve sleeve from block. This groove may be used to apply either an extractor or hooks.

VALVE SIZE	MEASUREMENTS			
	I. D.		A	
	(mm)	inches	(mm)	inches
16 mm	19. 0	0. 748	2. 0	0. 0787
25 mm	29. 0	1. 142	2. 5	0. 0984



Sleeves size 40 and up can be removed by fastening an extractor to the 2 tapped holes.

VALVE SIZE	MEASUREMENTS					
	THREAD		DIM.		A	
	(mm)	inches	(mm)	inches	(mm)	inches
40 mm	M5	——	54. 5	2. 145	7	0. 2755
50 mm	M5		66. 0	2. 598	7	0. 2755
63 mm	M6		88. 0	3. 464	9	0. 3543

To insure sustained efficiency and maximum trouble-free life of this precision equipment, initial and continuous filtration of the fluid medium to 25 microns absolute or less is essential. (For information pertaining to Sperry Vickers economical filters, see bulletin 81-216.)

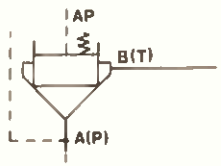
LITHO IN U.S.A.

Printed in U.S.A.

CARTRIDGE VALVES

MODEL SERIES CVI/CVC/CVGC

FOR PRESSURE RELIEF FUNCTIONS



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

GENERAL DATA

Cartridge relief valves feature manual pressure setting adjustment with a choice of adjustment designs. Additionally, venting and remote piloting are possible. Alternative arrangements include electrical selection of pressure or venting and of dual pressure settings and venting.

The cartridge insert fits into a DIN 24342 recess and consists of a sleeve, a seating spool (area ratio 1:1), and a closing spring.

It is retained by a control cover which contains the manually adjustable pilot valve and all piloting connections. One option provides an NFPA-DO1 mounting surface for pilot control valves or modules.

Cartridge valve characteristics can be matched to application requirements by adding suitable orifices in the pilot circuit.

The relief valve arrangements described in this bulletin can be built into system manifold assemblies with directional flow regulating and pressure reducing functions in cartridge form.

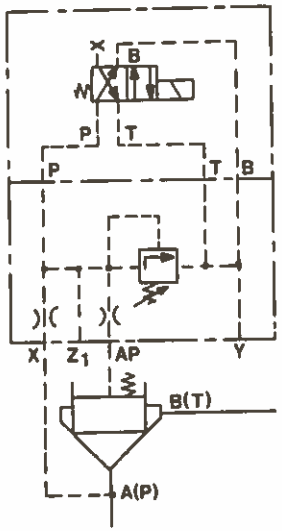
RATINGS

Nominal Sizes	16mm, 25mm and 40mm
Maximum Operating Pressure	350 Bar
Maximum Flow Rate (ΔP = 4 Bar)	70 to 700 l/min
Pressure Adjustment Ranges	5 to 125 Bar 5 to 245 Bar 5 to 350 Bar

FUNCTIONAL SYMBOLS

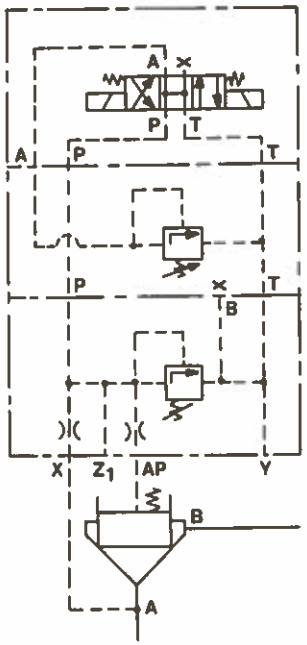
Typical constructions are symbolized here and shown on pages 7 to 9.

Note that in all cases:
z_1 = Vent port for remote hydraulic control. Block when not required.

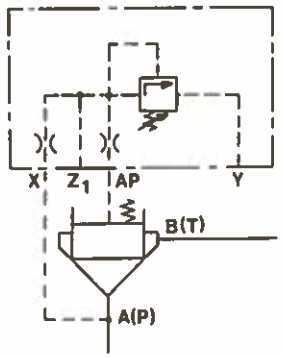


Pressure relief and venting functions, with electrical selection.

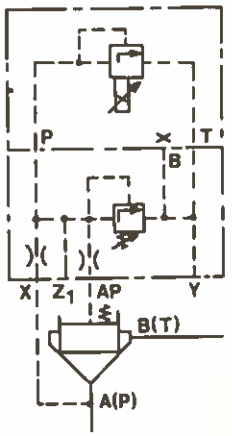
Y = Pilot relief exhaust. Can be internally drained to B(T) or externally drained.



Pressure relief functions, high and low adjustable settings plus venting by electrical selections.



Pressure relief function, with manual adjustment and venting feature.



Pressure relief function, by electrohydraulic proportional control.

OPERATING DATA

Unless otherwise stated, performances are based on mineral oil at 25 cSt and at 50°C (120°F).

Maximum Operating Pressure

Port "Y" ..... Up to 350 Bar (5000 PSI)

dependent on the maximum pressure for the tank port of any electrically controlled pilot valve.

All Other Ports ..... 350 Bar (5000 PSI)

Maximum Flow Rates

Based on 4 bar pressure drop with valve unloaded.

16mm .... 160 l/min (42 GPM)
25mm .... 400 l/min (106 GPM)
40mm .... 700 l/min (185 GPM)

CONTROL DATA

Manual Pressure Adjustment

Adjustment is located in the control cover. Adjustment options are shown on pages 7-9 and described on page 5.

Vent connection is provided for optional remote control by suitable pilot pressure or pilot directional control valve(s). These can simulate remotely the integral pilot options shown at left and on pages 7-9. For typical pilot flows see chart on page 4.

Pressure Relief and Venting Functions With Electrical Selection

This arrangement, utilizing a DG4V-3-2A-LH directional pilot valve to provide pressure relief plus venting by electrical selection, is illustrated on page 8. The circuit is symbolized on cover page. For details of the DG4V-3 series valve, ask for Vickers installation drawing 517351.

Pressure Relief Functions, High and Low Adjustable Settings Plus Venting, By Electrical Selection

A DG4V-3-OC double solenoid two-position pilot selector can be used together with a pilot pressure relief module to provide both high and low pressure settings plus venting by electrical selection. This compact arrangement is shown on page 8. The circuit is symbolized on cover page.

The pilot pressure relief module can be utilized as an integral control for 25mm and 40mm size cartridges or, with suitable interface closures, as a remote control for all sizes.

For details of the DG4V-3 series valve, ask for Vickers installation drawing 517351.

Pressure Relief Function With Electrohydraulic Proportional Control

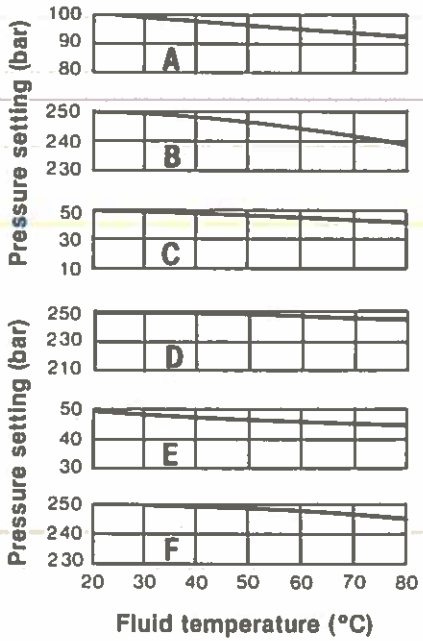
An electrically operated CGE-02 proportional pilot valve (see installation drawing 511050) can be incorporated to relieve pressure in proportion to the applied electrical current. The symbolic arrangement of the pressure relief function with electrohydraulic control is shown on cover page.

For use with the CGE-02, "B" port in the control cover must be plugged. When ordering, the cover should be specified with "B00" (to be shipped with "B" port plugged). Consult your Vickers representative for further details.

Pressure Stability

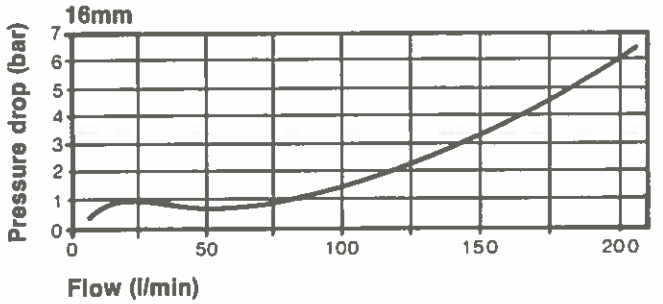
Curve No.	Nominal Size	Pressure Adjustment Range (Bar)	Flow (l/min.)
A B	16mm	5-125 5-350	80
C D	25mm	5-125 5-350	180
E F	40mm	5-125 5-350	700

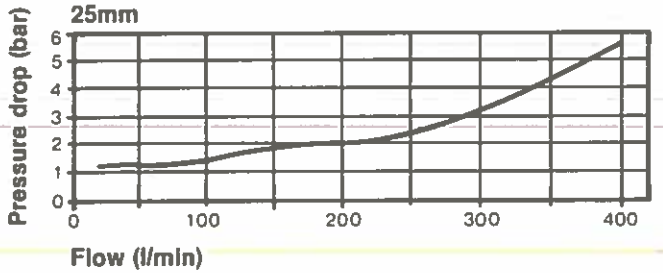
Pressure Stability

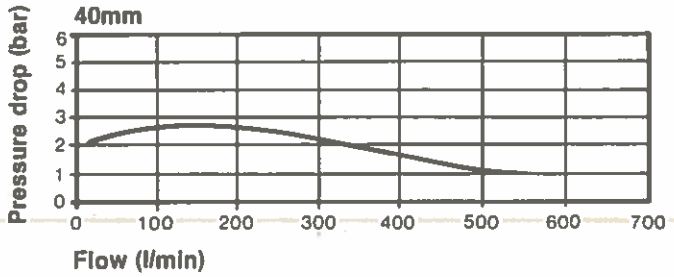


Pressure Drop Characteristics

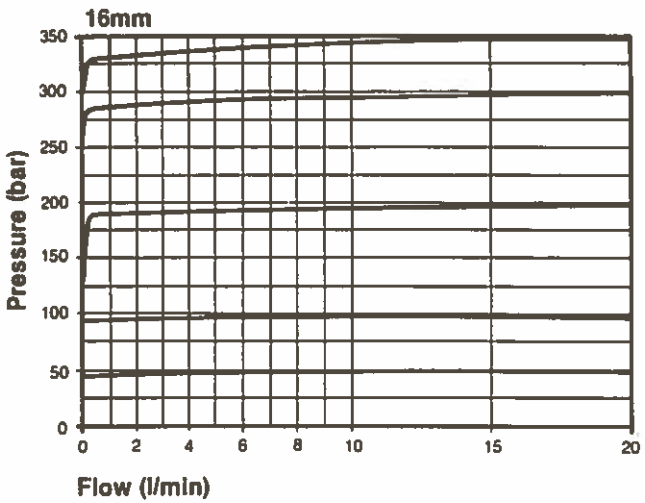
Pressure drop with main valve unloaded.

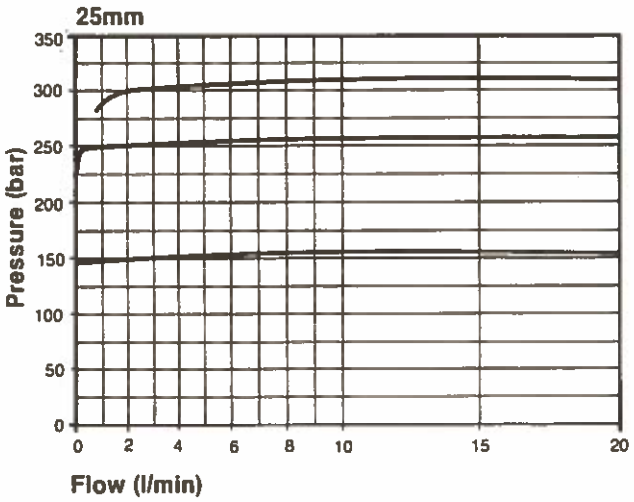


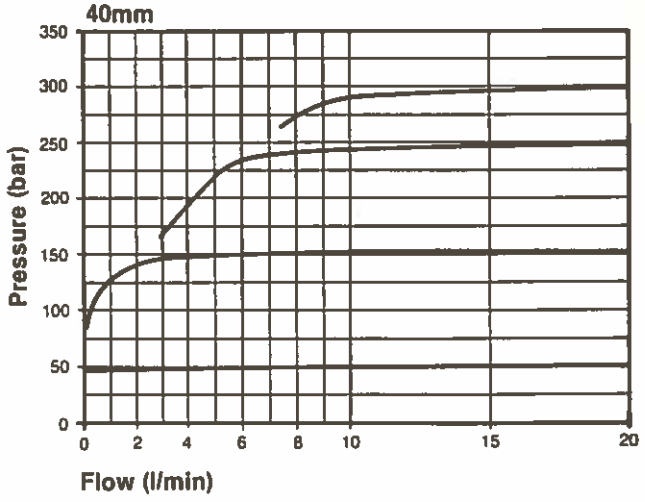




Pressure Override, Low Flow Zone

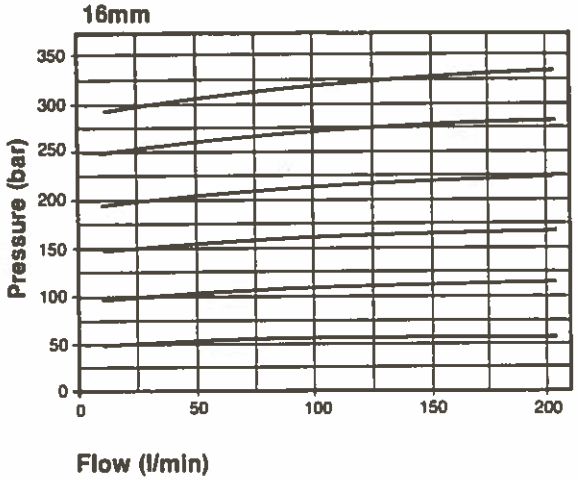


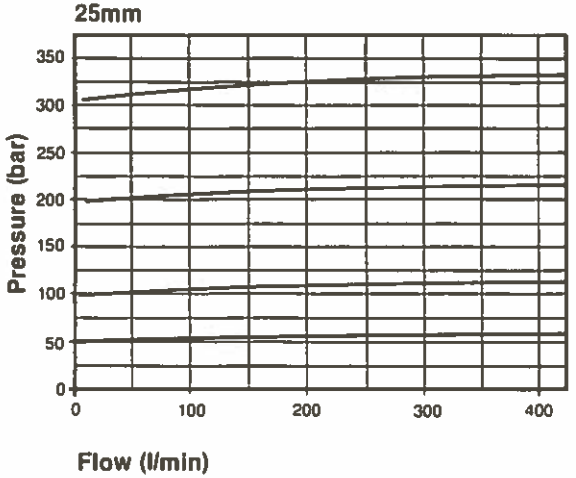


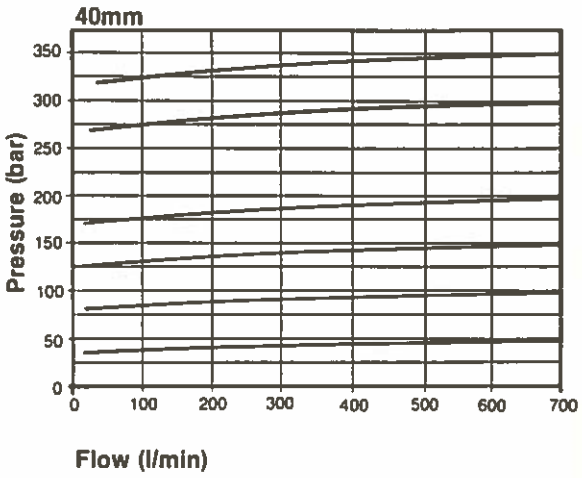


Pressure Override, High Flow Zone

Valves with manual pressure adjustment and with high and low pressure settings.







HYDRAULIC FLUIDS

All valves can be used with antiwear hydraulic oils, water-in-oil emulsions, water glycols and certain low viscosity fluids.

Note:
Add prefix "F3" to model designations of electrically operated pilot valves and order cartridge and module assemblies by special kit numbers, obtainable from Vickers when phosphate ester (not alkyl-based) or chlorinated hydrocarbons are to be used.

The extreme viscosity range is from 500 to 5 cSt but the recommended range is from 54 to 5 cSt. Consult Vickers if the minimum viscosity will be less than 13 cSt.

For further information about fluids, see Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400).

TEMPERATURE LIMITS

Ambient
Minimum ..... −10°C (14°F)
Maximum ..... +70°C (160°F)

Fluid Temperature
Mineral Oil
Minimum ..... −10°C (14°F)
Maximum* ..... +80°C (180°F)

Water Containing
Minimum ..... +10°C(50°F)
Maximum* ..... +54°C(130°F)

* To obtain optimum service life from both fluid and hydraulic system, 65°C(150°F) is normally the maximum temperature except for water-containing fluids.

For synthetic fluids consult manufacturer or Vickers representative where limits are outside those for mineral oil. Whatever the actual temperature range, ensure that viscosities stay within the limits specified in "Hydraulic Fluids" section.

FILTRATION REQUIREMENTS

Adequate fluid filtration for protection from environmental contaminant ingression and generated contaminants must be provided to ensure reliable system performance and long service life.

For cartridge valves, 10-micrometer-elements can be used to maintain most systems at an ISO cleanliness code of 18/13. This protection can be provided by Vickers OFP pressure filters and OFR or OFRS return line filters.

Refer to Section "P"-"Filters" and Section "S"-"Technical Information" of Vickers Catalog 400, or contact your Vickers representative for further filtration advice.

MOUNTING ATTITUDE

Unrestricted.

ORDERING PROCEDURE

Ask your Vickers representative for a quotation on a cartridge valve system tailored to your application, or quote the appropriate model code numbers in this brochure.

Pilot Control Flows

Nominal Valve Size	Pressure Pre-Set	Flow Rate Through Main Valve l/min (GPM)	Pilot Flow in l/min (GPM) At: 50 Bar	725 PSI	100 Bar	1450 PSI	200 Bar	2900 PSI	300 Bar	4350 PSI
			Millimeters (Inches)							
16mm	—In Control Cover	50 (13.2)	1.08	(.29)	1.24	(.33)	1.40	(.37)	1.52	(.40)
		160 (42.2)	1.54	(.41)	1.86	(.49)	2.24	(.59)	2.46	(.65)
25mm	—In Control Cover	20 (5.3)	0.98	(.26)	1.02	(.26)	1.08	(.29)	1.15	(.30)
		200 (52.8)	1.40	(.37)	1.65	(.44)	1.90	(.50)	2.10	(.55)
		400 (105.7)	1.62	(.43)	1.92	(.50)	2.30	(.60)	2.50	(.66)
	—In Pilot Relief Module	20 (5.3)	0.88	(.23)	0.92	(.24)	0.96	(.25)	1.00	(.26)
		200 (52.8)	1.30	(.34)	1.45	(.38)	1.70	(.45)	1.80	(.48)
		400 (105.7)	1.42	(.38)	1.75	(.46)	2.00	(.53)	2.20	(.58)
40mm	—In Control Cover	25 (6.6)	1.10	(.29)	1.15	(.30)	1.20	(.32)	1.28	(.34)
		400 (52.8)	1.76	(.46)	1.82	(.48)	2.10	(.55)	2.18	(.58)
		700 (184.9)	2.04	(.53)	2.36	(.62)	2.56	(.68)	2.80	(.74)
	—In Pilot Relief Module	25 (6.6)	1.12	(.30)	1.20	(.32)	1.24	(.33)	1.30	(.34)
		400 (52.8)	1.64	(.43)	1.95	(.52)	2.20	(.58)	2.30	(.61)
		700 (184.0)	1.80	(.48)	2.20	(.58)	2.70	(.71)	2.90	(.77)

WEIGHT

Cartridge and Pilot Valve Arrangements	Weight-Kg (Lbs.) 16mm	25mm	40mm
As page 7	2.0 (4.4)	2.8 (6.2)	8.2 (18.0)
As page 8, including single solenoid valve	—	4.5 (9.9)	9.9 (22.0)
As page 9, including double solenoid valve	—	6.2 (13.6)	11.6 (25.5)

ASSEMBLY NUMBERS

Pressure Relief and Venting Functions (Manual Adjustment)

Adjustment Arrangement CVC-••-C-S2-□-•••-10		Adjustment Range (Bar)								
		16mm			25mm			40mm		
		5-125	5-245	5-350	5-125	5-245	5-350	5-125	5-245	5-350
Micrometer Knob	M	579958	579959	579960	579998	579999	580225	580285	580286	580287
Micrometer Knob With Key-Lock	K	579961	579962	579963	580226	580227	580228	580288	580289	580290
Set Screw, Locknut and Cap	W	579952	579953	579954	579992	579993	579994	580279	580280	580281
Use Above Covers With Pressure Relief Insert 1:1 CVI-••-D10-2-10		579976			580259			580321		

Pressure Relief and Venting Functions (Electrical Selection)

Adjustment Arrangement CVC-••-C1-S2-□-•••-10		Adjustment Range (Bar)					
		25mm			40mm		
		5-125	5-245	5-350	5-125	5-245	5-350
Micrometer Knob	M	580232	580233	580234	580294	580295	580296
Micrometer Knob With Key-Lock	K	580235	580236	580237	280297	280298	280299
Set Screw, Locknut and Cap	W	580229	580230	580231	580291	580292	580293
Use Above Covers With Pressure Relief Insert 1:1 CVI-••-D10-2-10		580259			580321		

Pressure Relief Functions, High and Low Adjustable Settings Plus Venting By Electrical Selection

Manual Adjustment Arrangement CVGC-3-•-•••-10		Adjustment Range (Bar)		
		5-125	5-245	5-350
Micrometer Knob	M	580076	580077	580092
Micrometer Knob With Key-Lock	K	580261	580323	580324
Set Screw, Locknut and Cap	W	580031	580032	580033

MODEL CODE
Inserts

F* - CVI - 16 - D10 - 2 - ■ - 10 - ■ - ■

1 2 3 4 5 6 7 8 9

1 Special Seals

See "Hydraulic Fluids" note, page 4.

2 Cartridge Valve Insert

3 Valve Size

16 - 16mm
25 - 25mm
40 - 40mm

4 Function

D10 - Directional 1:1 (for relief use spring H only).

5 Seals

1 - DIN 3770 (Europe)
2 - ISO 3601 (Europe and USA)
3 - JIS B2401 (Japan)

6 Spring

Blank - Omit "H" spring is standard in the relief valve.

7 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

8 Model Suffix

For special features.

9 Orifices

Blank - Omit
08 - 0.8mm diameter
10 - 1.0mm diameter
12 - 1.2mm diameter
14 - 1.4mm diameter
16 - 1.6mm diameter
18 - 1.8mm diameter
20 - 2.0mm diameter

MODEL CODE
Modules

F* - CVGC - 3 - W - 125 - 10

1 2 3 4 5 6

1 Special Seals

See "Hydraulic Fluids" note, page 4.

2 Cartridge Valve Module

3 Size (Interface)

3 - CETOP RP35H Size 3 NFPA D01 (ISO 4401)

4 Pressure Adjustment Method

W - Screw locknut
M - Micrometer
K - Micrometer with key

5 Pressure Range

125 - 5 to 125 bar
250 - 5 to 250 bar
350 - 5 to 350 bar

6 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

MODEL CODE
Covers

F* - CVC - 16 - C - S2 - M - 125 - 10 - ■ - ■

1 2 3 4 5 6 7 8 9 10

1 Special Seals

See "Hydraulic Fluids" note, page 4.

2 Cartridge Valve Cover

3 Valve Size

16 - 16mm
25 - 25mm
40 - 40mm

4 Function

C - Relief
C1 - Relief, NFPA D01 (with inch threads). 25 & 40mm only.

5 Seals, Plugs, Bolts

(S2, B19, B29, etc.)

Codes
For Plugs:
B - BSP thread (Europe)
S - SAE thread (USA)
For Seals:
1 - DIN 3770 (Europe)
2 - ISO 3601 (Europe and USA)
3 - JIS B2401 (Japan)
For Bolts:
9 - With metric bolts (Europe)
Blank - Without any bolts (USA)

6 Adjustment Device

M - Micrometer
K - With key lock
W - With locknut

7 Pressure Range

125 - 125 bar
245 - 245 bar
350 - 350 bar

8 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

9 Model Suffix

For special features.

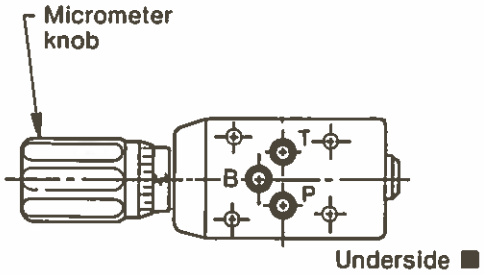
10 Orifices

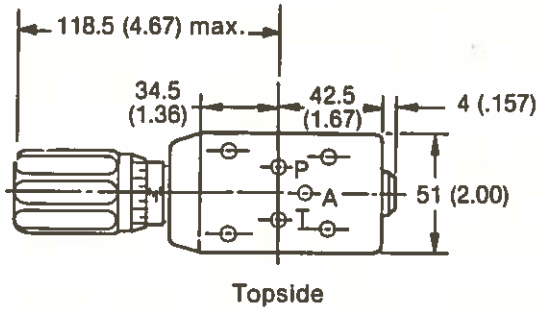
Omit if basic.
Deviations in location or size should be specified, e.g. "no orifice in AP port; 1.2mm orifice in Z2" should be coded "AP99-Z212" (see code below).

Codes
Pilot ports are X, Y, Z1, and AP.
08 - 0.8mm orifice
14 - 1.4mm orifice
99 - No orifice
00 - Plug

Examples
X08 - Orifice 0.8mm in port X.
Z112 - Orifice 1.2mm in port Z1.
Y99 - No orifice in port Y.
Z200 - Plug in port Z2.

Attaching bolt kit BK466851 is available separately for securing module and DG4V-3 directional control to the control cover. Torque bolts to 3.7 - 6.7 lbs.

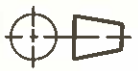




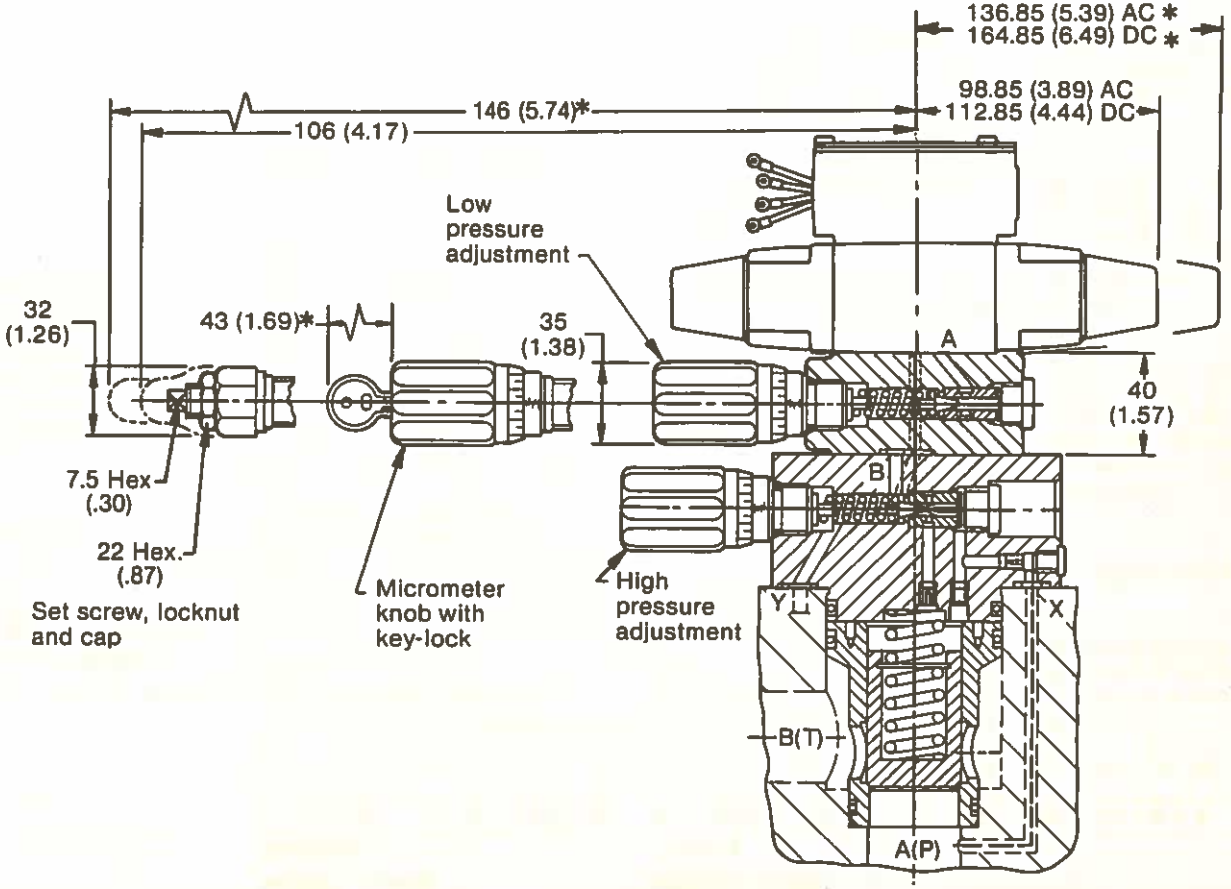
Pressure Relief Functions, High And Low Adjustable Settings Plus Venting (Electrical Selection)

Sizes 25mm and 40mm

Dimensions Shown In Millimeters and (Inches)



3rd Angle Projection



Note
40mm valve illustrated.

* Clearance for solenoid coil removal.
■ Mounting surfaces to NFPA-DO1 except that ports "B" in the directional valve and the control cover are blocked by the module.

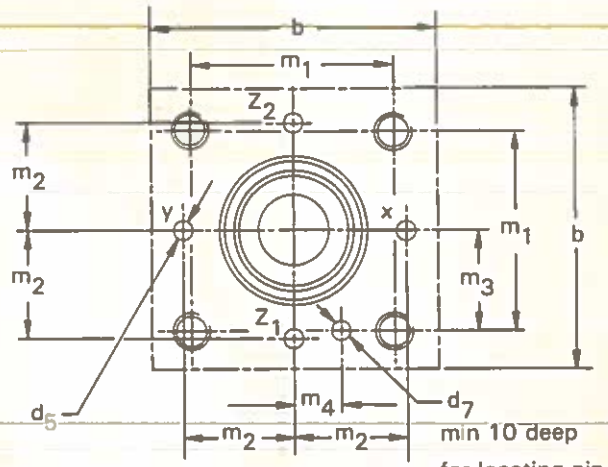
519210-9

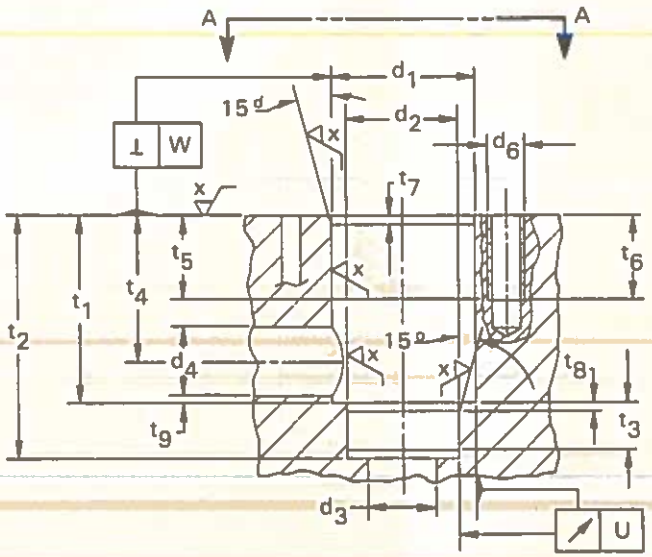
Recess Dimensions To DIN 24342

Dimension	Nominal Size—Metric (Inches)		
	16mm	25mm	40mm
b	65 (2.56)	85 (3.35)	125 (4.92)
d_1	32.000 (1.2598) 32.025 (1.2608)	45.000 (1.7717) 45.025 (1.7726)	75.000 (2.9528) 75.030 (2.9539)
d_2	25.000 (0.9843) 25.021 (0.9851)	34.000 (1.3386) 34.025 (1.3396)	55.000 (2.1653) 55.030 (2.1665)
d_3 maximum	16 (.63)	25 (.98)	40 (1.57)
d_4	16 (.63)	25 (.98)	40 (1.57)
d_4 maximum	25 (.98)	32 (1.26)	50 (1.97)
d_5 maximum	4 (.157)	6 (.236)	10 (.393)
d_6 Thread	M8 (.3125-18)	M12 (.500-13)	M20 (.750-10)
d_7	4.000 (.1575) 4.180 (.1646)	6.000 (.2362) 6.180 (.2433)	6.000 (.2362) 6.180 (.2433)
m_1 ±0.2(±.008)	46 (1.811)	58 (2.284)	85 (3.347)
m_2 ±0.2(±.008)	25 (.984)	33 (1.299)	50 (1.969)
m_3 ±0.2(±.008)	23 (.906)	29 (1.142)	42.5 (1.674)
m_4 ±0.2(±.008)	10.5 (.414)	16 (.630)	23 (.906)
t_1 +0.1(+.004)	43 (1.692)	58 (2.283)	87 (3.425)
t_2 +0.1(+.004)	56 (2.204)	72 (2.834)	105 (4.133)
t_3*	11 (.433)	12 (.472)	15 (.590)
t_4	34 (1.338)	44 (1.732)	64 (2.519)
t_4 to d_4 maximum	29.5 (1.161)	40.5 (1.594)	59 (2.322)
t_5*	20 (.787)	30 (1.181)	30 (1.181)
t_6 Thread Depth	20 (.787)	25 (.984)	35 (1.377)
t_7	2 (.078)	2.5 (.098)	3 (.118)
t_8	2 (.078)	2.5 (.098)	3 (.118)
t_9	1.5 (.059)	1.5 (.059)	3 (.118)
U	0.03 (.0012)	0.03 (.0012)	0.05 (.0020)
W	0.05 (.002)	0.05 (.002)	0.1 (.0039)
X_{Ra}	1.6 micrometer (63 microinches)		

*Depth of finish "X_{Ra}" in hole.

Recess Dimensions to DIN 24342



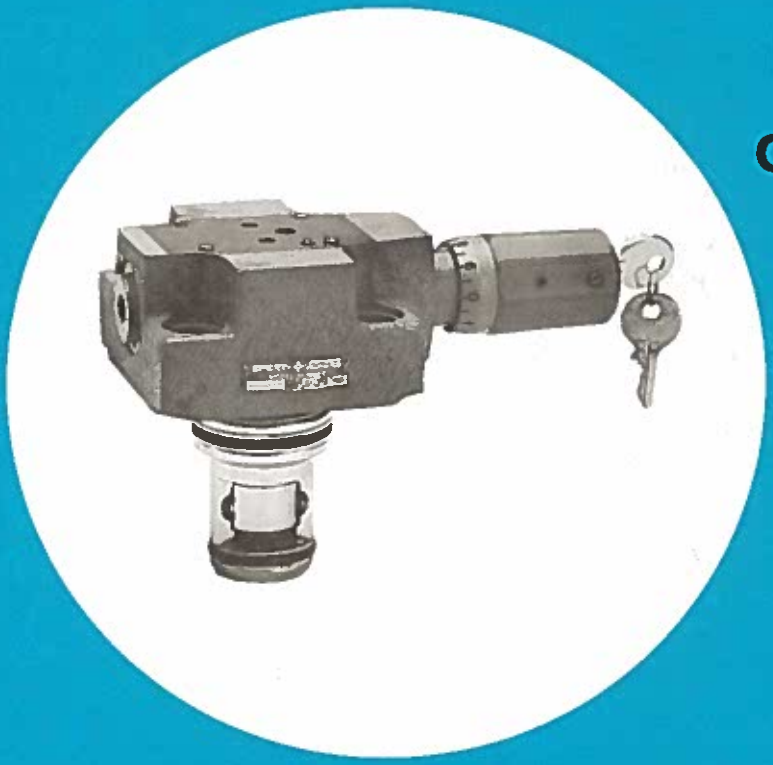


519210-10

SPERRY VICKERS

26

PRESSURE RELIEF CARTRIDGE VALVES



OVERHAUL MANUAL

CVC-16/25/40-C(1)-S2-*-***-10 COVER

CVI-16/25/40-*-2-10 INSERT

Revised 6-1-84

SPERRY VICKERS, TROY, MI 48084
VICKERS, INCORPORATED, IS A SUBSIDIARY OF SPERRY CORPORATION
SPERRY VICKERS IS A REGISTERED TRADEMARK OF SPERRY CORPORATION

I-3639-S

TABLE OF CONTENTS

SECTION		PAGE
I	INTRODUCTION	
	A. Purpose of Manual	1
	B. General Information	1
	C. Model Codes	1
II	DESCRIPTION	
	A. General	3
	B. Valve Construction	3
III	PRINCIPLES OF OPERATION	
	A. Standard Relief Valve	4
	B. Vent Function	4
	C. Model Variations with NFPA-D01/ISO-4401-3 Interface Cover	4
IV	INSTALLATION AND OPERATING INSTRUCTIONS	
	A. Installation Drawings	8
	B. Mounting	8
	C. Piping & Tubing	8
	D. Hydraulic Fluid Recommendations	8
	E. Overload Protection	8
	F. Replacement Parts	8
	G. Product Life	8
	H. Troubleshooting	8
V	SERVICE AND MAINTENANCE	
	A. Service Tools	11
	B. Inspection	11
	C. Adding Fluid to System	11
	D. Adjustments	11
	E. Lubrication	11
VI	OVERHAUL	
	A. Cover Removal	11
	B. Subassemblies Available for Cartridge Valves with Standard Covers	11
	C. Removal of Adjuster Mechanisms from Cover	12
	D. Removal of Standard and Interface Cover Parts	12
	E. Disassembly of Low Pressure Module	14
	F. Removal of Cartridge Insert from Manifold	15
	G. Subassemblies Available for Cartridge Valves with Interface Covers	15
	H. Inspection Repair and Replacement	16
	I. Cartridge Valve Assembly	16
VII	PRESSURE CALIBRATION	
	A. Calibration on a Test Stand	17
	B. Calibration on the Machine	18
	C. Calibration of Relief Valve Module	18

A. PURPOSE OF MANUAL

This manual describes basic operation characteristics and provides service and overhaul information for Sperry Vickers cartridge type pressure relief valves.

B. GENERAL INFORMATION

Related Publications - Installation dimensions are not contained in this manual. Cartridge valve installation drawings are listed in Table 1. Installation drawings are available from any Sperry Vickers engineering office or from:

Sperry Vickers
Technical Publications
1401 Crooks Road
Troy, MI 48084

VALVE TYPE	INSTALLATION DRAWINGS		
	16mm	25mm	40mm
Pressure Relief Valve	Installation information is shown in advertising brochure 317.		

Table 1. Related Publications

C. MODEL CODES

The model code, Table 2a, depicts cover variables.

The model number stamped into the cover nameplate does not identify the cartridge valve insert. To identify standard cartridge insert parts, refer to Section I-B-2 and Table 11, of this manual. The cartridge insert model code is shown in Table 2b.

MODEL CODE BREAKDOWN

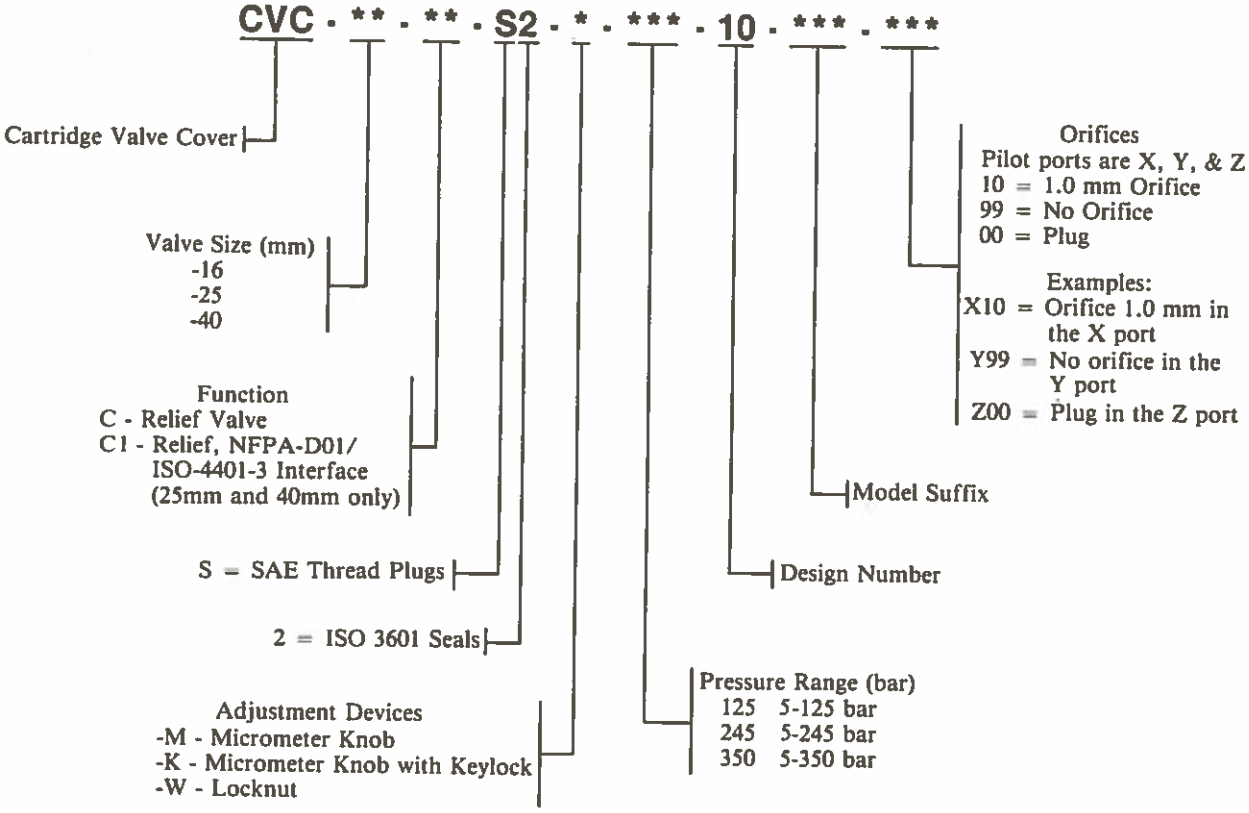

CVC - ** - ** - S2 - * - *** - 10 - *** - ***
Cartridge Valve Cover
Valve Size (mm)
-16
-25
-40
Function
C - Relief Valve
C1 - Relief, NFPA-D01/ ISO-4401-3 Interface (25mm and 40mm only)
S = SAE Thread Plugs
2 = ISO 3601 Seals
Adjustment Devices
-M - Micrometer Knob
-K - Micrometer Knob with Keylock
-W - Locknut
Pressure Range (bar)
125 5-125 bar
245 5-245 bar
350 5-350 bar
Design Number
Model Suffix
Orifices
Pilot ports are X, Y, & Z
10 = 1.0 mm Orifice
99 = No Orifice
00 = Plug
Examples:
X10 = Orifice 1.0 mm in the X port
Y99 = No orifice in the Y port
Z00 = Plug in the Z port

Table 2a. Cover Model Code Breakdown

MODEL CODE BREAKDOWN

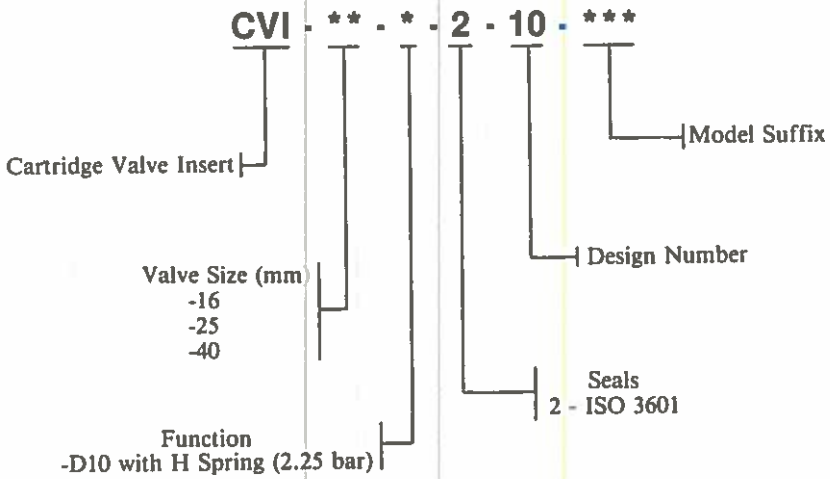


Table 2b. Cartridge Valve Insert Model Code Breakdown

Section II - DESCRIPTION

A. GENERAL

Cartridge relief valves are constructed in two sections. One section is called the cover section which contains the pilot valve adjustment mechanism for controlling pressure. The other section is a cartridge valve insert section. Spool diameters of 16mm, 25mm, and 40mm are available.

Cover parts also vary according to valve size and type of adjuster. The following adjusters are available (see Table 3). An exploded view showing item numbers for disassembly and assembly sequence can be found in Section VI.

MANUAL ADJUSTER TYPE	FIGURE NUMBER
With Locknut	7
With Micrometer Knob	9
With Micrometer Knob & Key	9

Table 3. Location of Adjuster Exploded Views

B. VALVE CONSTRUCTION

NOTE

Cartridge relief valve covers are mounted to the manifold with four (4) cap screws. The cover retains the valve insert within the manifold cavity.

1. Standard Covers - The cover S/A contains the pressure relief valve pilot stage (head), consisting of a seat, poppet, spring, orifice, seals, adjuster mechanism and vent connection (see Figure 1).

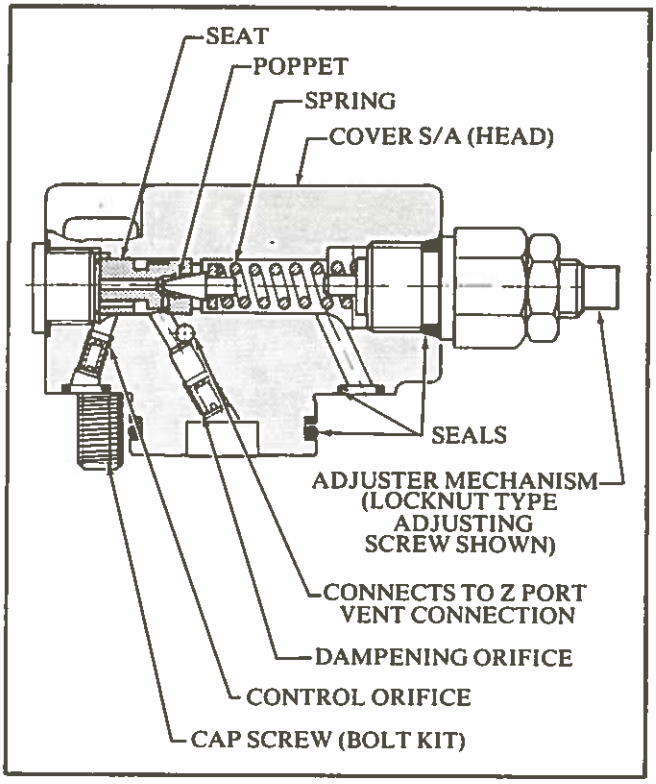


Figure 1. Relief Valve Pilot Stage Head (Standard Cover)

2. Standard Cartridge Insert Construction - Cartridge relief valve inserts are constructed as shown in Figure 2. The entire cartridge insert is placed within a manifold designed and drilled to provide the necessary port openings and operating circuit. Each cartridge valve insert is comprised of a sleeve, spool, spring and associated seals.

a. The sleeve contains 'O' ring grooves, port openings and a seat for the spool.

b. The standard spool area ratio is 1:1. This means that the outside diameter (O.D.) of the spool is the same throughout its length. A spool with a 1:1 ratio requires the same pressure on top and bottom to be in pressure balance.

NOTE

In some special instances, spool ratios other than the standard 1:1 are used. If your cartridge insert is not a 1:1 ratio as shown in Figure 2, refer to drawing 1-3638-S for identification of the cartridge insert subassembly used in your unit.

c. The spring holds the spool against its seat in the pressure balanced condition.

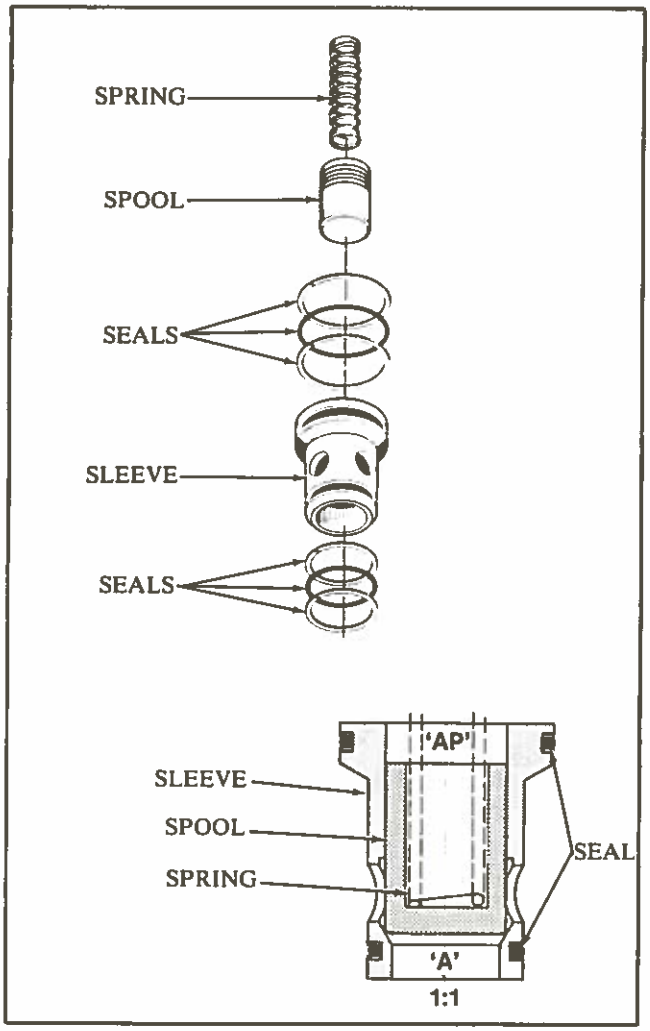


Figure 2. Cartridge Insert Kit Exploded and Sectional Views

A. STANDARD RELIEF VALVE

Figure 3 illustrates valve operation. The pressure setting of the valve is determined by the position of the adjusting screw which varies spring compression.

In normal operation, the 'B' port is connected to tank. The 'A' and 'X' ports are interconnected within the manifold and system pressure is present at 'A'.

The system pressure at 'A' port is fed to the 'X' port and communicated through the control orifice into area 'AP'. Area 'AP' is located directly above the cartridge insert spool. This allows the cartridge insert spool to be in hydraulic balance and held against its seat by a light spring. NOTE: The orifice located in the 'AP' areas feed passage, is used to slow reaction time of the spool and prevents instability.

When system pressure at 'A' exceeds the cover spring setting it forces the pilot poppet away from its seat. Fluid will flow through the control orifice across the poppet into the spring chamber, and from the spring chamber through the 'Y' port to tank. Flow through the control orifice develops a pressure drop that subtracts from system pressure. The orifice pressure drop prevents pressure in the 'AP' area from rising above pilot poppet cracking pressure. When system pressure at the 'A' port exceeds pressure of the 'AP' area sufficiently, the cartridge insert spool will lift and throttle fluid from 'A' to 'B', the tank port. This relieves system pressure at 'A'.

B. VENT FUNCTION

Venting the valve by opening area 'AP' to tank will permit flow to occur from 'A' to 'B' at a low pressure. NOTE: Vent pressure is limited only by the light spring of the cartridge insert spool plus any back pressure present in the vent line. The 'AP' area is connected internally within the cover to the 'Z' port. Opening the 'Z' port to tank vents the valve.

C. MODEL VARIATIONS USING THE NFPA-D01/ISO-4401-3 INTERFACE COVER

NOTE

Various other cartridge relief valve configurations exist. These valves function similarly to the basic relief valve with the exceptions noted in the following paragraphs.

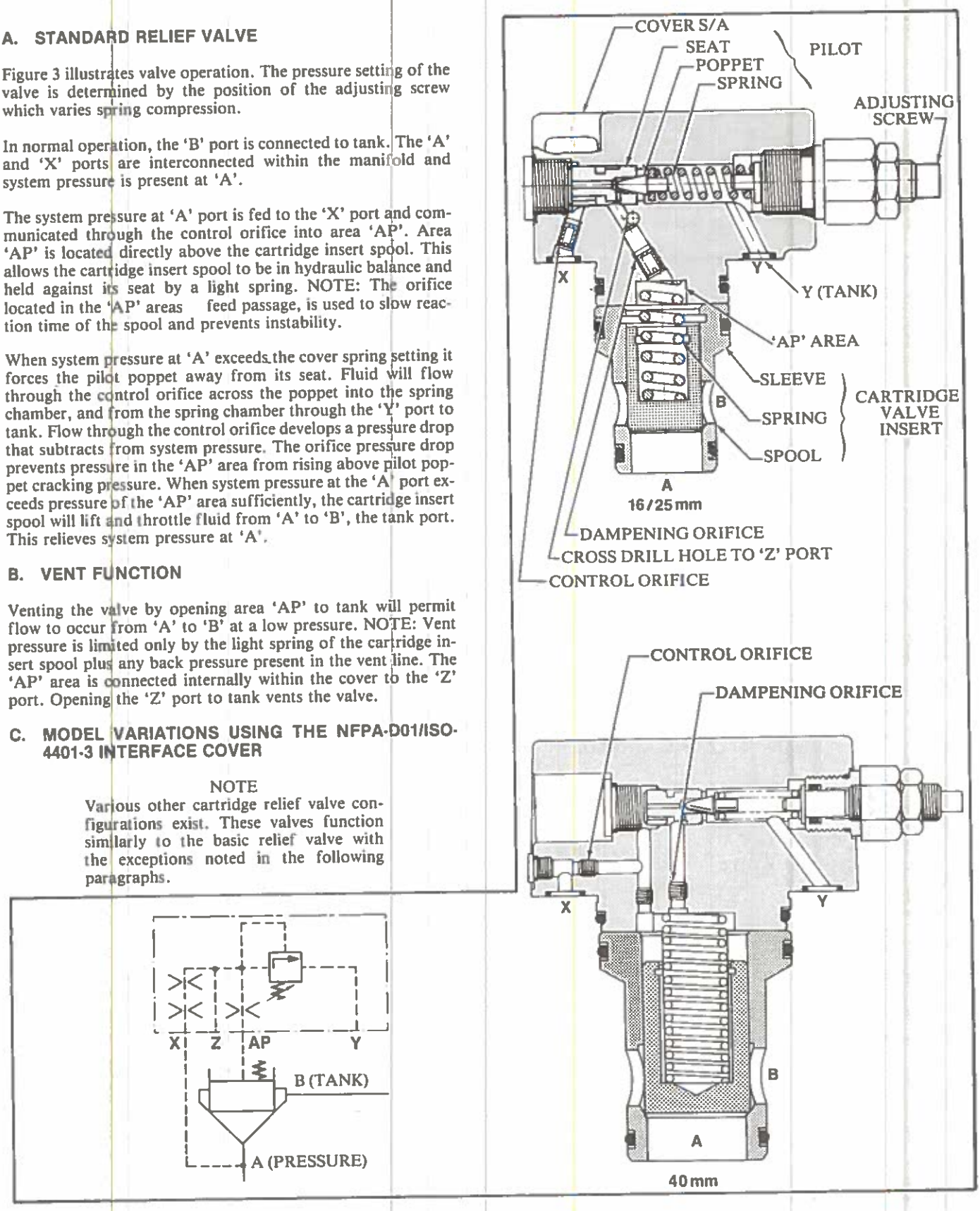


Figure 3. Pressure Relief Function with Manual Adjustment and Venting Feature

1. Pressure Relief and Venting Functions with Electrical Selection (See Figure 4) - An offset directional valve is attached to the relief valve cover interface and controls valve functions. When the valve solenoid is de-energized, the relief valve is vented to tank through the directional valve P-B ports. If the solenoid is energized, the 'P' port is blocked and the valve operates at the relief valve pressure setting. The 'Z' port is a remote vent connection. Block the 'Z' port if the remote vent feature is not used.

2. Pressure Relief High and Low Adjustable Settings Plus Venting by Electrical Selection (See Figure 5) - In this configuration, a spring centered directional valve controls two relief valve pilot stages to provide two different relief pressures. Also, in the de-energized condition of the solenoids, the relief valve is vented to tank.

The 'Z' port is a remote vent connection. Block the 'Z' port if the remote vent feature is not used.

The highest pressure setting is controlled by the pilot valve located in the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. At least 10.3 bar (150 PSIG) spread is required between the high and low pressure settings to prevent interaction.

3. Electrically Modulated Relief Valve Function (See Figure 6) - The cartridge valve NFPA-D01/ISO-4401-3 interface cover accommodates the CGE-02-*-22 electrically modulated relief valve. This valve can be remotely controlled by a micro-computer or a regulated power supply with appropriate voltage/current control. Normally as current increases, pressure drop across the CGE valve increases. This will cause the cartridge relief valve pressure to follow the CGE valve.

Pressure drop across the CGE valve cannot exceed the manual relief pressure setting of the cartridge valve.

The CGE-02-*-22 electrically modulated relief valve is designed for 207 bar (3000 PSIG) operation in the standard valve configuration. Special valves are available to extend this range through 345 bar (5000 PSIG).

The 'Z' port is a remote vent connection. Block the 'Z' port if the remote vent feature is not used.

A solid (M6 metric) plug (part number 471131) or SAE hex key plug (310169) *must* be installed into the 'B' port opening of the interface cover.

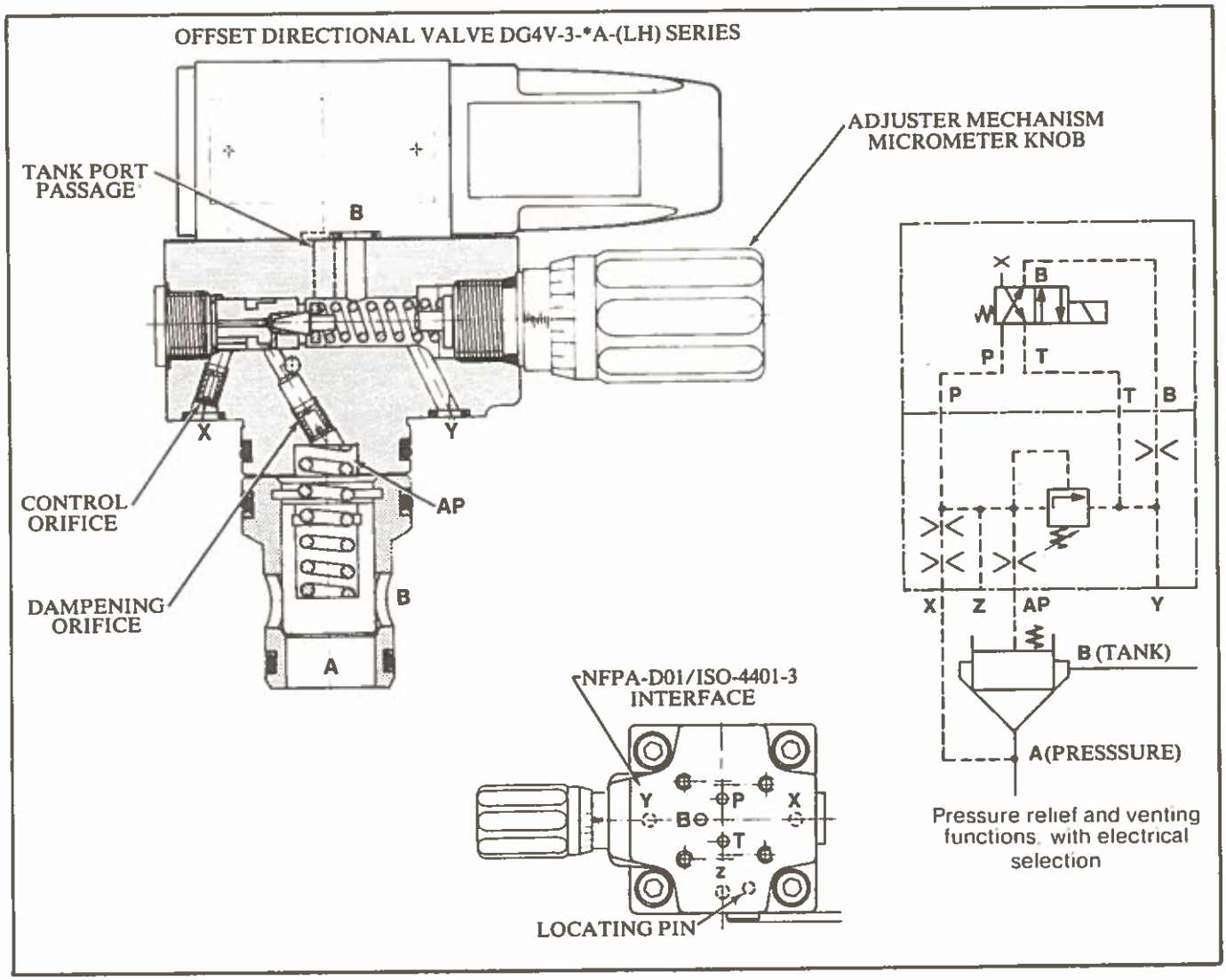


Figure 4. Pressure Relief and Vent Function with Electrical Selection

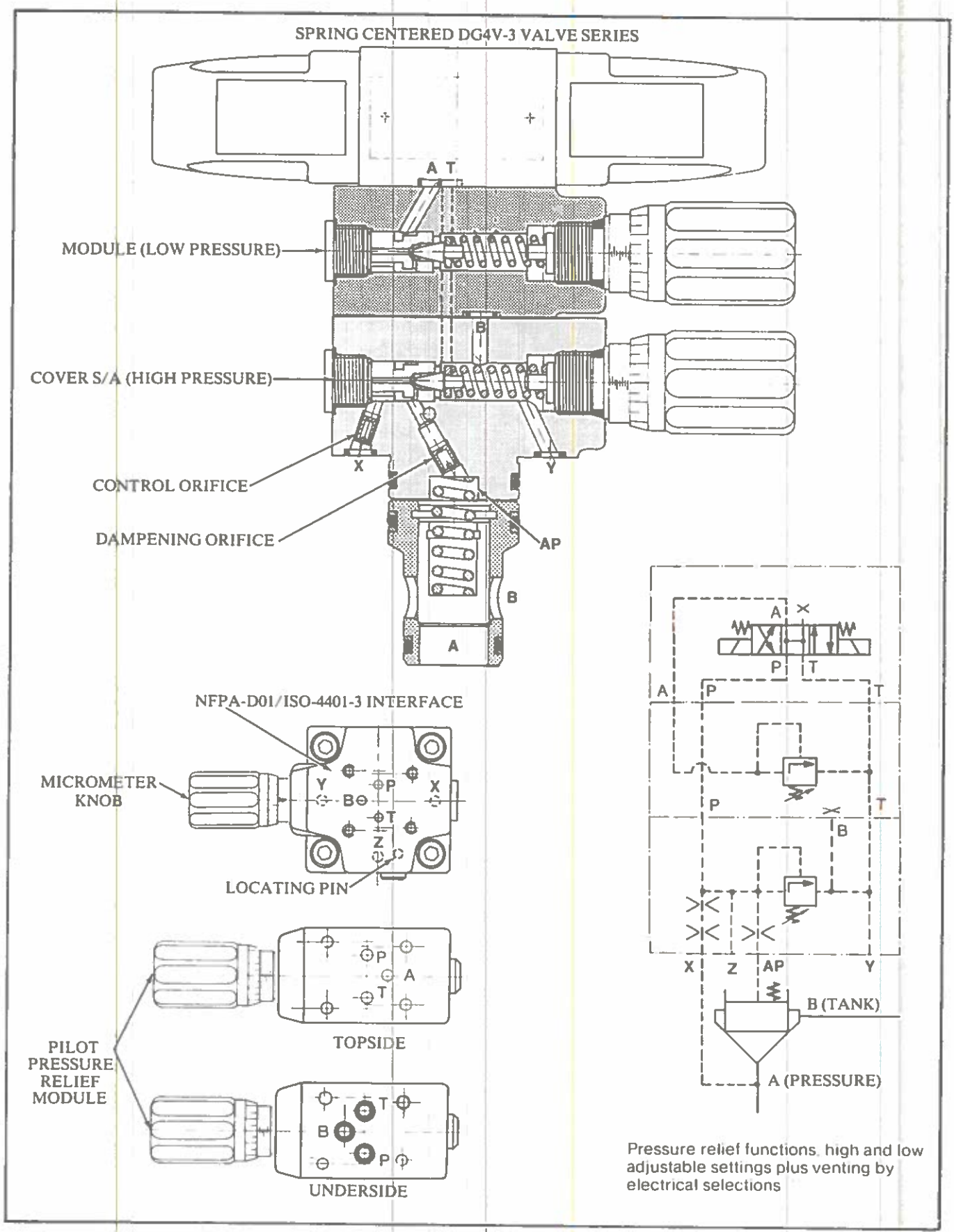


Figure 5. Pressure Relief High and Low Adjustable Settings Plus Venting by Electrical Selection.

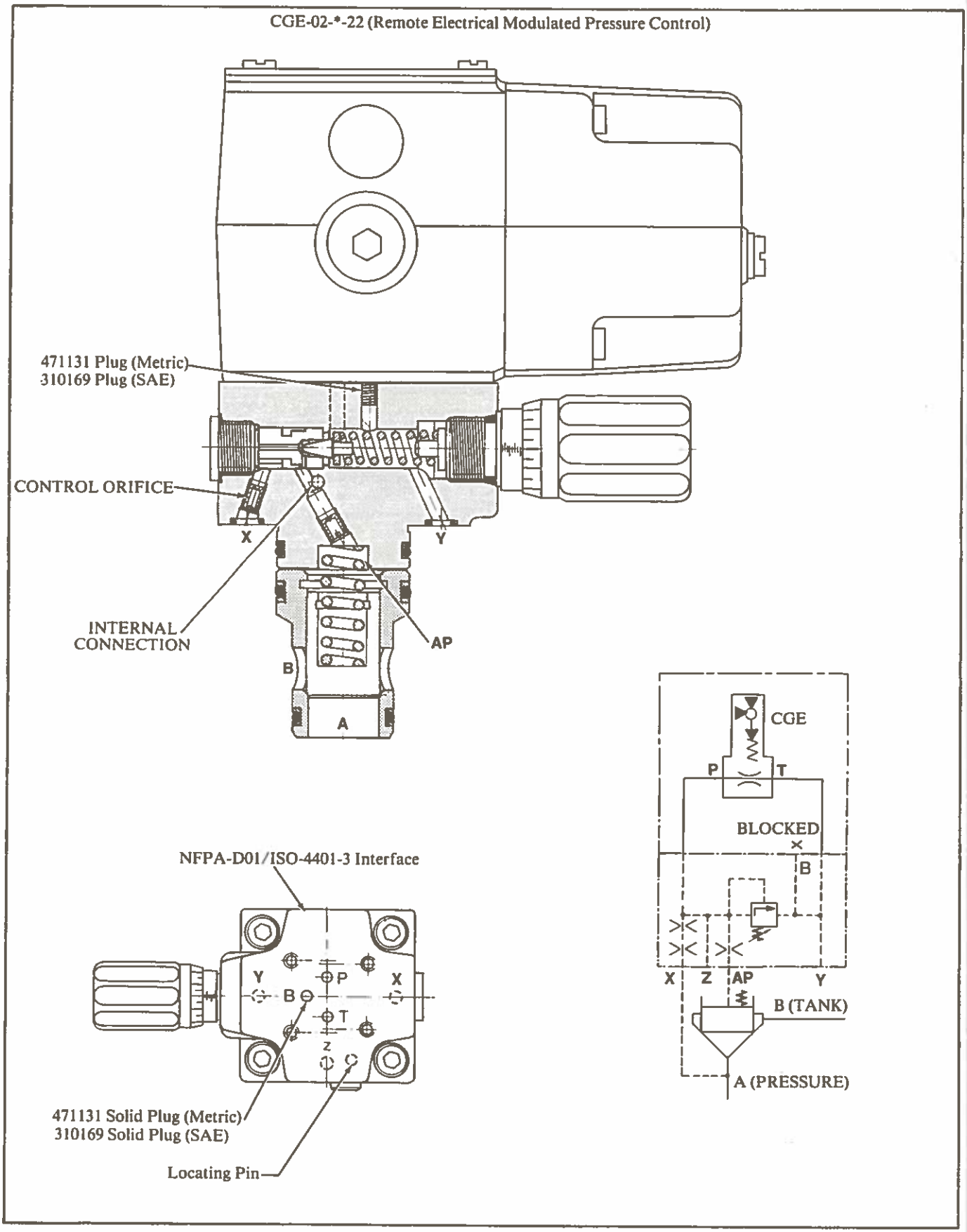


Figure 6. Electrically Modulated Relief Function

Section IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS - The installation drawings listed in Table 1 show installation dimensions and port locations.

B. MOUNTING - Cartridge relief valves are designed to be installed into manifolds with most circuit connections within the manifold. This minimizes external circuit connections and provides a very compact package. Each cartridge relief valve installation is unique for a specific application. Many other valve functions can be included within the same manifold.

C. PIPING AND TUBING - If a cartridge relief valve is part of a manifold system that is actuator mounted, only pressure and tank lines will be required. All pipes and tubing must be thoroughly cleaned along with all passages within the manifold. Recommended methods of cleaning are sandblasting, wire brushing, pickling and power flushing.

NOTE
For instruction on pickling, refer to instruction sheet 1221-S.

1. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

2. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

D. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components. Any oil selected for use with relief valves must also be acceptable for the system pumping source and actuator.

Data sheet I-286-S for oil selection is available from Sperry Vickers Technical Publications, Troy, MI.

Oil recommendations noted in the data sheet is based on our experience in industry as a hydraulic component manufacturer. Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Sperry Vickers representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminants into the system.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination by sealing the system and/or by proper filtration of the air.

5. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc. cannot be over emphasized.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similiar to cavitation.

E. OVERLOAD PROTECTION

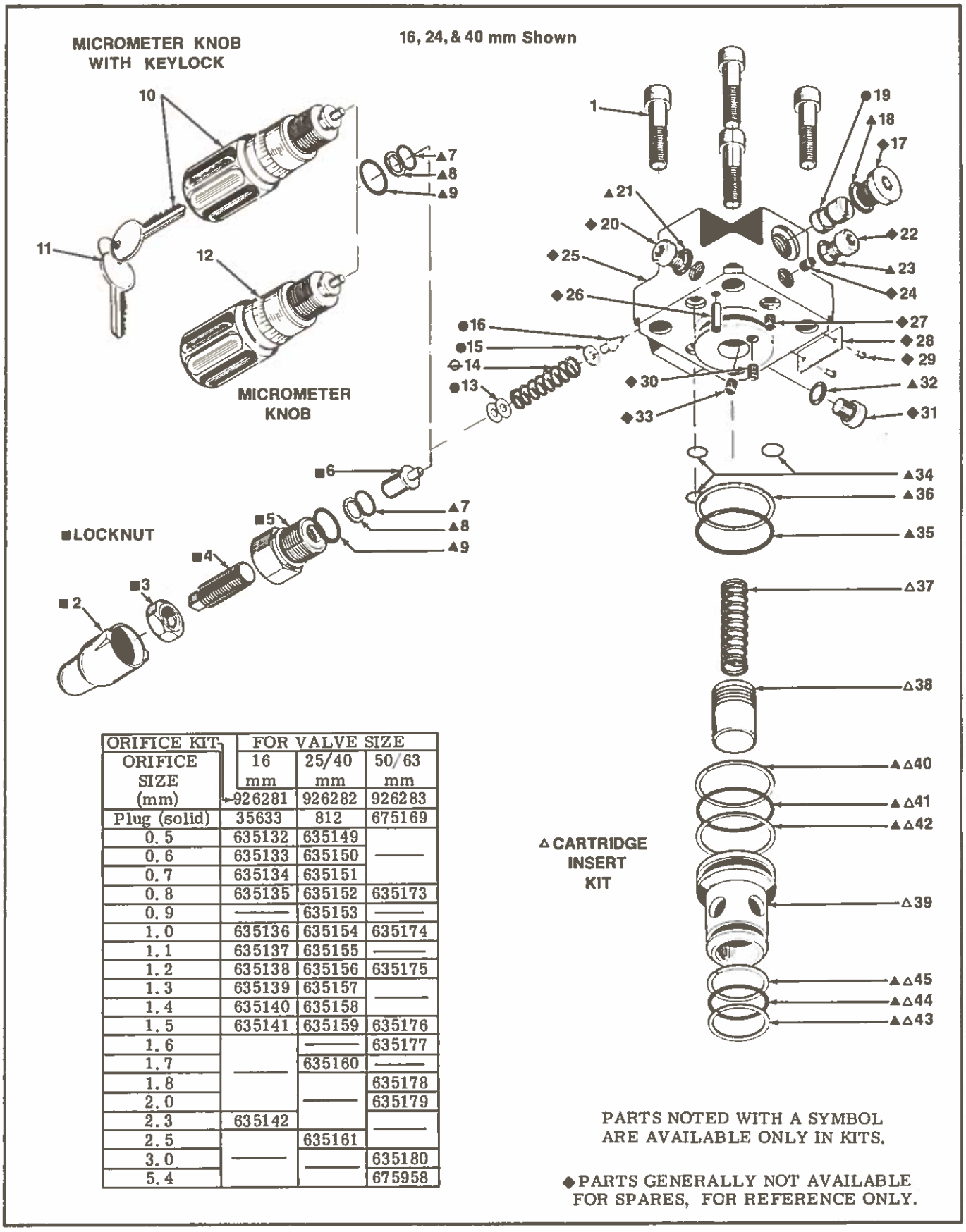
The cartridge relief valve limits pressure in the system to a prescribed maximum and protects components from excessive pressure. The setting of the cartridge relief valve depends on the design and work requirements of the system.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Sperry Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutions may result in early failure.

G. TROUBLESHOOTING

By applying the basic operating principles discussed up to this point, a technician can in a relatively short time become proficient in the troubleshooting of cartridge relief valve circuits. Basically, the relief valve is a check valve and the pilot valve cover arrangement controls the various pressures that open and close the cartridge check valve.


MICROMETER KNOB WITH KEYLOCK
16, 24, & 40 mm Shown
MICROMETER KNOB
■LOCKNUT
△CARTRIDGE INSERT KIT
PARTS NOTED WITH A SYMBOL ARE AVAILABLE ONLY IN KITS.
◆PARTS GENERALLY NOT AVAILABLE FOR SPARES, FOR REFERENCE ONLY.

ORIFICE KIT → ORIFICE SIZE (mm)	FOR VALVE SIZE 16 mm	25/40 mm	50/63 mm
	926281	926282	926283
Plug (solid)	35633	812	675169
0.5	635132	635149	
0.6	635133	635150	———
0.7	635134	635151	
0.8	635135	635152	635173
0.9	———	635153	———
1.0	635136	635154	635174
1.1	635137	635155	———
1.2	635138	635156	635175
1.3	635139	635157	
1.4	635140	635158	———
1.5	635141	635159	635176
1.6		———	635177
1.7	———	635160	———
1.8			635178
2.0		———	635179
2.3	635142		———
2.5		635161	
3.0	———	———	635180
5.4			675958

Figure 7. Exploded View of Relief Valve

ITEM NO.	PART NO. 16mm	PART NO. 25mm	PART NO. 40mm	DESCRIPTION	UNITS/ ASSEMBLY
1		SEE TABLE 9		Bolt Kit (Cover)	1
		SEE FIGURE 11		Bolt Kit (Directional Valve)	1
■ 2	762607	762607	762607	Cap	1
■ 3	761190	761190	761190	Locknut	1
■ 4	762918	762918	762918	Adjusting Screw	1
■ 5	579922	579922	579922	Adapter	1
	(Torque to 100 N. m - 74 lb. ft.)				
■ 6	762919	762919	762919	Bolt Adjustment	1
▲ 7	262350	262350	262350	"O"Ring	1
▲ 8	197588	197588	197588	Back Up Ring	1
▲ 9	262355	262355	262355	"O" Ring	1
10	762936	762936	762936	Micrometer Knob & Keylock S/A	1
◆11	814573	814573	814573	Keys	1 Set (2)
12	762935	762935	762935	Micrometer Knob S/A	1
●13	762920	762920	762920	Shims	A/R
⊖14	762928	726928	726928	5 - 125 bar Spring	1
	762929	762929	762929	5 - 245 bar Spring	1
	762930	762930	762930	5 - 350 bar Spring	1
●15	762921	762921	762921	Washer	1
●16	290057	290057	290057	Poppet	1
◆17	329463	329463	329462	Plug (SAE)	1
	(Torque to 54-59 N. m - 40-43 lb. ft.)				
▲18	263497	263497	263497	"O" Ring	1
●19	762922	762922	762922	Seat	1
◆20	591768	591768	591768	Plug (SAE)	1
	(Torque to 9.8 - 10.2 N. m - 87-90 lb. ft.)				
▲21	154124	154124	154124	"O" Ring	1
◆22	———	———	591768	Plug (SAE)	1
	(Torque to 9.8 - 10.2 N. m - 87-90 lb. ft.)				
▲23	———	———	263492	"O"Ring	1
∗◆24	———	———	635158	Control Orifice (DO NOT REMOVE)	1
25		SEE TABLE 10		Cover - Standard	1
		SEE TABLE 12		Cover - Interface	1
◆26	161236	226797	226797	Rest Pin	1
∗◆27	635135	635152	———	Control Orifice (DO NOT REMOVE)	1
◆28	199082	199082	199082	Nameplate	1
◆29	AX-36212	AX-36212	AX-36212	Screws	2
∗◆30	———	———	812	Plug (DO NOT REMOVE)	1
◆31	———	———	398071	Plug (SAE)	1
	(Torque to 9.8 - 10.2 N. m - 87-90 lb. ft.)				
▲32	———	———	154124	"O" Ring	1
∗◆33	635138	635156	635159	Dampening Orifice	1
▲34	200082	200083	200085	"O" Ring	3
▲35	179347	154126	154086	"O" Ring	1
▲36	271732	271787	271795	Back Up Ring	1
△37	580041	580082	580329	Spring	1
△38	762927	762990	763056	Spool	1
△39	579983	580267	580238	Sleeve	1
▲△40	271732	271787	271795	Back Up Ring	1
▲△41	179347	154026	154086	"O" Ring	1
▲△42	271732	271787	271795	Back Up Ring	1
▲△43	271728	271734	271790	"O" Ring	1
▲△44	199812	151733	154079	"O" Ring	1
▲△45	271728	271734	271790	Back Up Ring	1
	▲920172	920174	920176	SEAL KIT (Includes parts with ▲)	1
	920173	920175	920177	F3 Equivalent SEAL KIT	1
	△(Cartridge Valve Insert Kit, See Table 11)				1
	■941472	941472	941472	Locknut Adjuster Kit	1
	●941473	941473	941473	Poppet & Seal Kit	1
	∗926281	926282	926283	Orifice Kit (See Figure 7)	

Figure 7. Relief Valve Cover Parts List

Section V · SERVICE AND MAINTENANCE

A. SERVICE TOOLS

1. Torque wrench with hex bit adapter sockets. (Refer to unit being repaired and use the appropriate torque wrench.)

Size/mm	Torque (Maximum)	
	N.m	lb. ft.
16	35	25.9
25	110	81.4
40	500	370.0

Table 8. Maximum Torque Wrench Size Required

2. Set of U.S. and metric hex key wrenches
3. Set of small pin punches
4. 3/8 inch ratchet with sockets
5. Small ball peen hammer
6. Metric ruler
7. 3/8 inch length of brass rod (approx. 15 cm (6 in.) long)

SPECIAL TOOLS - No special tools required.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants.

If the fluid becomes contaminated, the system should be drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin system components. If bubbles are seen, locate the source of the air and seal the leak.

5. A unit which is running excessively hot or noisy is a potential failure. Should a unit become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the hydraulic unit. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

Manual adjustments are provided to adjust system pressure. The adjustment of fixed orifices will not be required. System orifices are determined during design of the equipment.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of external adjusters is required on a periodic basis.

Section VI · OVERHAUL

CAUTION

Before breaking a circuit connection, make sure that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

CAUTION

Absolute cleanliness is essential when working with a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Discard and replace all 'O' rings and back-up rings removed during disassembly.

A. COVER REMOVAL

Loosen and remove the four cover bolts, item (1) in Figure 7. Pull cover from the manifold. Do not remove cartridge insert at this time.

B. SUBASSEMBLIES AVAILABLE FOR CARTRIDGE VALVES WITH STANDARD COVERS

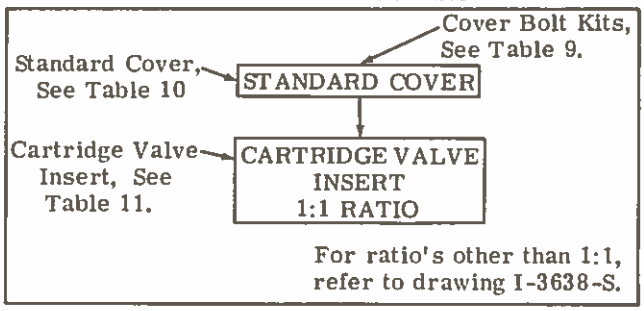

Cover Bolt Kits, See Table 9.
Standard Cover, See Table 10
STANDARD COVER
Cartridge Valve Insert, See Table 11.
CARTRIDGE VALVE INSERT 1:1 RATIO
For ratio's other than 1:1, refer to drawing I-3638-S.

Figure 8

COVER BOLT KITS			
TYPE	16mm	25mm	40mm
Inch	590702	590704	590706
mm	590703	590705	590707
Torque	35 N. m 26 lb. ft.	110 N. m 81 lb. ft.	500 N. m 368 lb. ft.

Table 9.

STANDARD COVERS					COVER NO. (REFERENCE)
COVER SIZE	PRESSURE RANGE	LOCKNUT	MICROMETER KNOB	MICRO. KNOB & KEYLOCK	
16mm	5 -125 bar	579952	579958	579961	◆579982
	5 -245 bar	579953	579959	579962	
	5 -350 bar	579954	579960	579963	
25mm	5 -125 bar	579992	579998	580226	◆580266
	5 -245 bar	579993	579999	580227	
	5 -350 bar	579994	580225	580228	
40mm	5 -125 bar	580279	580285	580288	◆580327
	5 -245 bar	580280	580286	580289	
	5 -350 bar	580281	580287	580290	

◆Not Available for Spares

Table 10.

△STANDARD 1:1 RATIO CARTRIDGE VALVE INSERT KITS		
16mm	25mm	40mm
579976	580259	580321

Table 11.

C. REMOVAL OF ADJUSTER MECHANISMS FROM COVER (Refer to Figure 7)

1. Locknut Adjuster - Remove locknut adjuster parts (2 through 9) in numerical sequence.

2. Micrometer Knob - Refer to Figure 9.

a. Push rollpin (1) into bolt (4).

b. Pull adjuster knob (2) and scale ring (3) from assembly to expose adjustment rod (9) and bolt (4).

c. Push rollpin (6) through adjustment rod (9) and thread adjustment rod and bolt counterclockwise from adapter (16). Press rollpin (1) through bolt. Retain rollpins (1 & 6) for assembly.

d. Push two rollpins (10) into adapter (16) just enough to remove retaining ring (11). Remove retaining ring, ratchet plate (12), ball (13), spring (14) and scale (15).

e. Thread adapter (16) from cover and remove 'O' rings (17 & 18). Discard the 'O' rings.

f. Press two rollpins (10) through adapter (16) into the center threaded area and remove. Retain the rollpins for assembly.

g. Slide adjusting pin (19) from adapter (16).

h. Remove 'O' ring (20) and back-up ring (21) from within adapter (16) and discard.

3. Micrometer Knob with Keylock - Refer to Figure 9

a. Unlock adjuster knob (2) with key (5) and rotate knob to engage detent (less than one turn).

b. Push rollpin (7) into adjustment rod (9).

c. Lock adjuster knob (2) and remove key (5). Pull adjuster knob and keylock (5) from assembly to expose adjustment rod (9).

d. Push rollpins (6 & 7) through adjustment rod (9), then thread adjustment rod (9) counterclockwise from adapter (16).

e. Push two rollpins (10) into adapter (16) just enough to remove retaining ring (11). Remove retaining ring, ratchet plate (12), ball (13), spring (14) and scale (15).

f. Thread adapter (16) from cover and remove 'O' rings (17 & 18). Discard the 'O' rings.

g. Press two rollpins (10) through adapter (16) into the center threaded area and remove. Retain the rollpins for assembly.

h. Slide adjusting pin (19) from adapter (16).

i. Remove 'O' ring (20) and back-up ring (21) from within adapter (16) and discard.

D. REMOVAL OF STANDARD AND INTERFACE COVER PARTS (Refer to Figure 7)

1. Remove parts (13 through 18) in numerical sequence.

2. DO NOT remove seat (19) unless inspection of poppet (16) reveals a problem.

3. Remove plug and 'O' ring (20 & 21).

NOTE
The following step (4) pertains to 40mm valves only.

4. Remove plug and 'O' ring (22 & 23). DO NOT remove orifice plug (24). Orifices are bonded in place with a special compound.

5. DO NOT remove rest pin (26) from cover (25) unless it is damaged.

NOTE
DO NOT remove orifices 27, 30 and 33. Orifices are bonded in place with a special compound.

6. DO NOT remove nameplate (28) or screws (29) from cover. These parts are not available as service items.

NOTE
The following step (7) pertains to the 40mm size valves only.

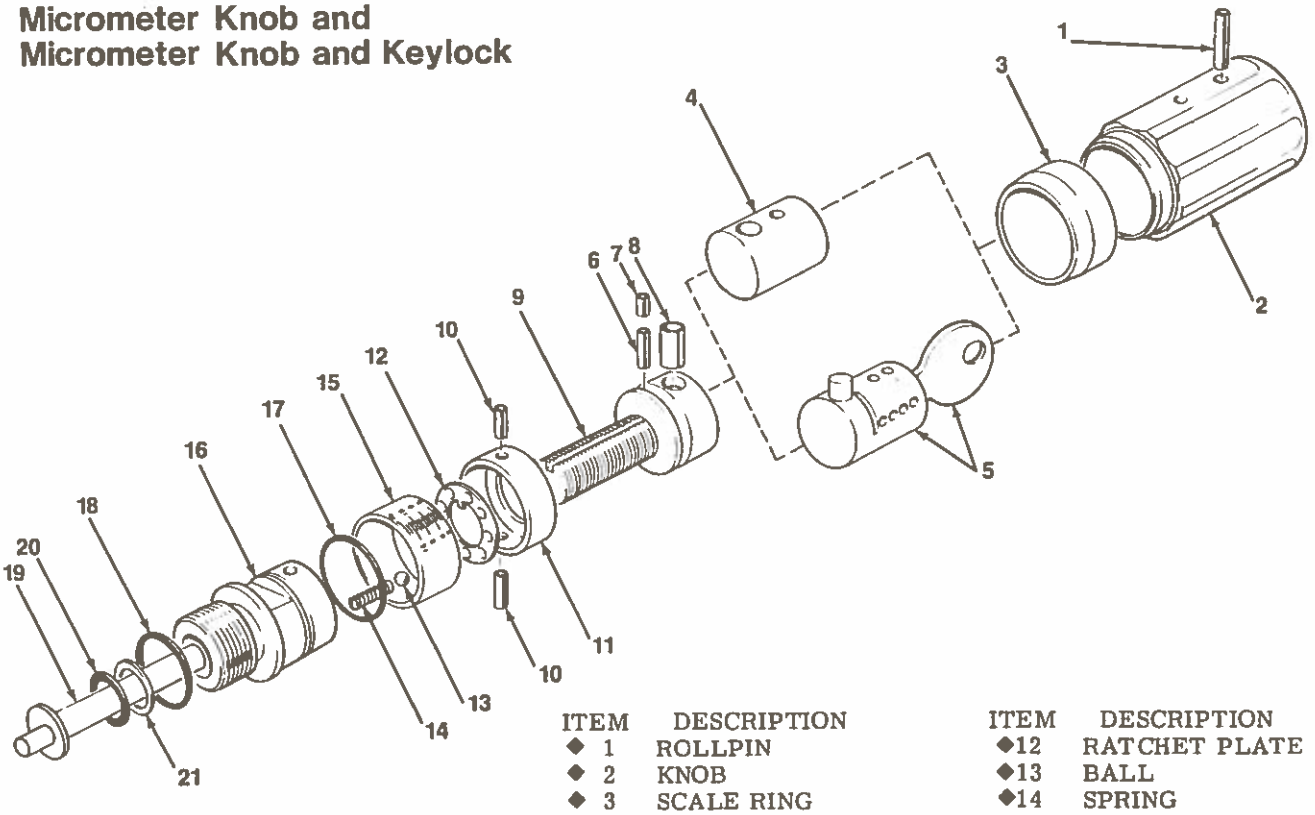
7. Remove plug and 'O' ring (31 & 32).

8. Remove seals (34 through 36) and discard.

NOTE
The following step (9) pertains to interface cover units only.

9. Remove directional control, or electrically modulated pressure control attaching screws. Separate the valve parts from the cover. Discard 'O' rings.

Micrometer Knob and
Micrometer Knob and Keylock



ITEM	DESCRIPTION
◆ 1	ROLLPIN
◆ 2	KNOB
◆ 3	SCALE RING
◆ 4	BOLT
◆ 5	KEYLOCK
◆ 6	ROLLPIN
◆ 7	ROLLPIN
◆ 8	ROLLPIN
◆ 9	ADJUSTING ROD
◆10	ROLLPIN
◆11	RETAINING RING

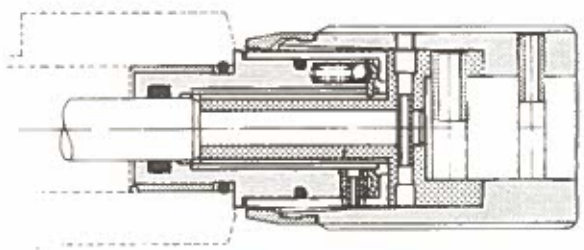
ITEM	DESCRIPTION
◆12	RATCHET PLATE
◆13	BALL
◆14	SPRING
◆15	SCALE
◆16	ADAPTER
▲17	"O" RING
18	"O" RING
19	ADJUSTING PIN
20	"O" RING
21	BACK UP RING

Figure 9. Exploded View

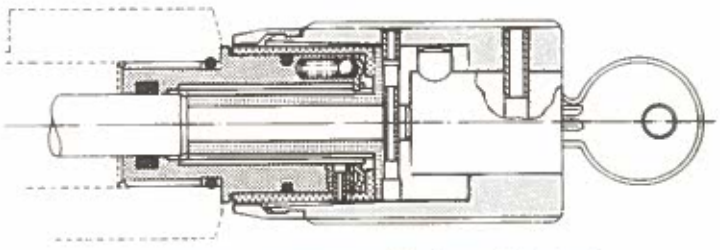
◆ INDIVIDUAL ITEMS ARE NOT AVAILABLE AS SPARE PARTS.
REFER TO FIGURE 7, PARTS TABULATION, FOR ADJUSTER S/A'S.

▲ INCLUDED IN SEAL KITS.

MICROMETER KNOB AND KEYLOCK SEAL KIT 920233



Adjuster Micrometer



Adjuster Micrometer Knob and Keylock

E. DISASSEMBLY OF LOW PRESSURE MODULE (See Figure 10)

1. Disassemble the manual adjusters as noted in Section VI-C.

2. Remove parts (13 through 18) in numerical sequence.

3. DO NOT remove seat (19) unless inspection of poppet (16) reveals a problem.

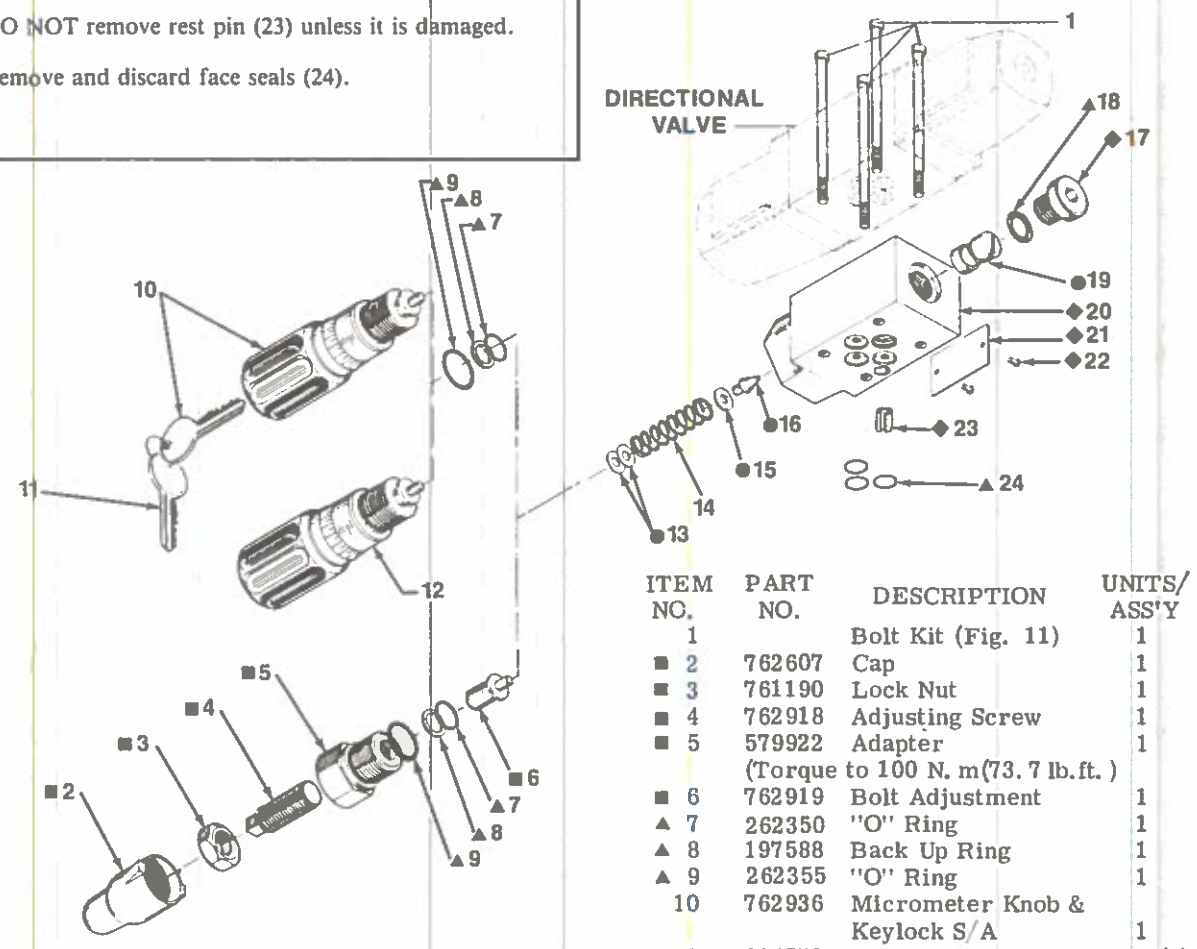
4. DO NOT remove nameplate (21) or screws (22). These parts are not available as service items.

5. DO NOT remove rest pin (23) unless it is damaged.

6. Remove and discard face seals (24).

◆ PARTS GENERALLY NOT AVAILABLE FOR SPARES, FOR REFERENCE ONLY.

PARTS NOTED WITH A PREFIX SYMBOL ARE AVAILABLE ONLY IN KITS.



ITEM NO.	PART NO.	DESCRIPTION	UNITS/ ASS'Y
1		Bolt Kit (Fig. 11)	1
■ 2	762607	Cap	1
■ 3	761190	Lock Nut	1
■ 4	762918	Adjusting Screw	1
■ 5	579922	Adapter	1
		(Torque to 100 N. m(73. 7 lb.ft.)	
■ 6	762919	Bolt Adjustment	1
▲ 7	262350	"O" Ring	1
▲ 8	197588	Back Up Ring	1
▲ 9	262355	"O" Ring	1
10	762936	Micrometer Knob & Keylock S/A	1
11	814573	Keys	1 set (2)
12	762935	Micrometer Knob	1
●13	762920	Shims	A/R
14	762928	5 - 125 bar Spring	1
	762929	5 - 245 bar Spring	1
	762930	5 - 350 bar Spring	1
●15	762921	Washer	1
●16	290057	Poppet	1
◆17	329463	Plug (SAE)	1
		(Torque to 54-59 N. m, 40-43 lb. ft.)	
▲18	263497	"O" Ring	1
●19	762922	Seat	1
◆20	580036	Body	1
◆21	199082	Nameplate	1
22	AX-36212	Screw	2
23	472553	Rest Pin	1
▲24	154006	"O" Ring	4

▲	920257	Seal Kit Includes parts noted with ▲
	920258	F3 Equivalent seal kit
■	941472	Locknut adjuster kit
●	941473	Poppet & Seat kit

Figure 10. Exploded View of Low Pressure Module Assembly.

F. REMOVAL OF CARTRIDGE INSERT FROM THE MANIFOLD (See Figure 7)

1. Remove spring (37) and spool (38) from sleeve (39).

2. Insert two hooked tools (hex key wrenches) into the 'B' port openings of sleeve (39). Pull sleeve from the manifold. Be careful not to scratch the inside surface finish of the sleeve during removal.

3. Remove and discard sealing parts (40 through 45) in item number sequence.

G. SUBASSEMBLIES AVAILABLE FOR CARTRIDGE VALVES WITH INTERFACE COVERS (See Figure 11)

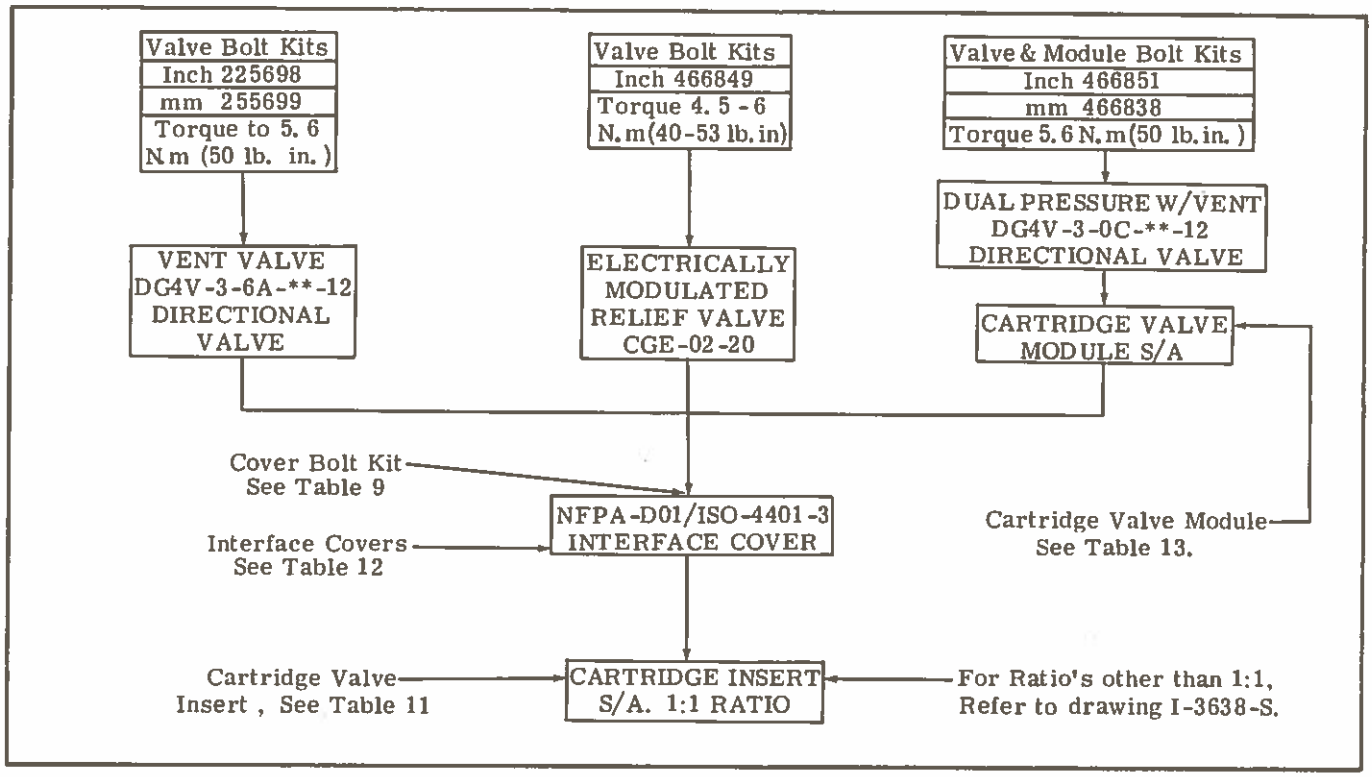

Valve Bolt Kits
Inch 225698
mm 255699
Torque to 5.6 Nm (50 lb. in.)
Valve Bolt Kits
Inch 466849
Torque 4.5 - 6 N.m(40-53 lb.in)
Valve & Module Bolt Kits
Inch 466851
mm 466838
Torque 5.6 N.m(50 lb.in.)
DUAL PRESSURE W/VENT DG4V-3-0C-**-12 DIRECTIONAL VALVE
VENT VALVE DG4V-3-6A-**-12 DIRECTIONAL VALVE
ELECTRICALLY MODULATED RELIEF VALVE CGE-02-20
CARTRIDGE VALVE MODULE S/A
Cover Bolt Kit See Table 9
Interface Covers See Table 12
NFPA-D01/ISO-4401-3 INTERFACE COVER
Cartridge Valve Module See Table 13.
Cartridge Valve Insert , See Table 11
CARTRIDGE INSERT S/A. 1:1 RATIO
For Ratio's other than 1:1, Refer to drawing I-3638-S.

Figure 11.

NFPA-D01/ISO-4401-3 INTERFACE COVERS					COVER (REFERENCE)
COVER SIZE	PRESSURE RANGE	LOCKNUT	MICROMETER KNOB	MICRO. KNOB & KEYLOCK	
25mm	5 - 125 bar	580229	580232	580235	◆ 580265
	5 - 245 bar	580230	580233	580236	
	5 - 350 bar	580231	580234	580237	
40mm	5 - 125 bar	580291	580294	580297	◆ 580326
	5 - 245 bar	580292	580295	580298	
	5 - 350 bar	580293	580296	580299	

◆ Not Available for Spares.

Table 12.

CARTRIDGE VALVE MODULE S/A					SPRING (REFERENCE)
COVER SIZE	PRESSURE RANGE	LOCKNUT	MICROMETER KNOB	MICRO. KNOB & KEYLOCK	
25mm & 40mm	5 - 125 bar	580031	580076	580261	762928
	5 - 245 bar	580032	580077	580323	762929
	5 - 350 bar	580033	580092	580324	762930

Table 13.

H. INSPECTION REPAIR AND REPLACEMENT

NOTE

Replace all parts that do not meet the following specifications.

CAUTION

DO NOT intermix parts from different valves or parts of a single valve. Poppets, springs and shims along with the cartridge spools are mated parts. Poppets and spools develop a wear pattern and may leak if interchanged to a different position in the valve.

NOTE

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning the cover orifices, and manifold passages.

1. Inspect all components for wear, erosion and/or seizure. Inspect manifold for burrs and sharp edges that may cause a sealing problem.

2. Inspect adjuster mechanism parts for wear. Replace the complete mechanism if parts are found unfit for service.

3. Inspect springs (14 & 37) to be square and straight. Replace springs that show evidence of wear.

4. Inspect the cartridge insert spool (38) for wear and erosion of the seat area. If wear is evident, replace the complete cartridge insert kit.

5. If a pilot poppet (16) requires replacement, replace the poppet and seat (19) as a set. Refer to Figure 7. To replace the seat, use a brass rod and press or drive the seat from the body or cover. The new seat should be lubricated with system fluid and pressed into the bore until it bottoms against a shoulder within the body or cover.

If the seat is replaced, the new poppet must be mated to the seat prior to installation within the cover. The following is an explanation of the mating operation:

a. Place the seat on a flat metal surface with the seat poppet opening up.

b. Position the poppet within the seat and hold the stem vertical and centered.

c. Tap the end of the poppet a couple of times with a small hammer.

d. Remove the poppet and observe a contact impression around its perimeter. If the contact impression is broken, repeat the mating operation.

e. Install seat (19) into the cover and clean up the relief valve cover or body to remove any debris that may have developed during the installation.

I. CARTRIDGE VALVE ASSEMBLY (Refer to Figure 7)

NOTE

Obtain a complete seal kit for the unit being repaired. Refer to Figure 7 for the seal kit information.

NOTE

Assembly is accomplished in the reverse item number sequence. Special procedures are noted in the following text.

1. Install sealing parts (45 through 40) on sleeve (39). Lubricate with system fluid to facilitate assembly.

2. Install sleeve (39) within the manifold. Some difficulty may be encountered due to the 'O' rings and back-up rings. A hardwood block and large 'C' clamp may be useful during installation of the sleeve.

3. Install spool (38) and spring (37) into the sleeve. Cover with paper to prevent contamination until assembly of the cover is accomplished.

4. Assemble back-up ring (36) and 'O' ring groove of the cover.

NOTE

The following step (5) pertains to 40mm interface covers only.

5. Install 'O' ring (32) on plug (31) and thread in place within cover (25). Torque plug to 3.4-4.0 N.m (30-35 lb. in.).

NOTE

The following step (6) pertains to both standard and interface 40mm covers.

6. Install 'O' ring (23) on plug (22) and thread in place within cover (25). Torque to 3.4-4.0 N.m (30-35 lb. in.).

7. Install 'O' ring (21) on plug (20) and thread in place. Torque to 3.4-4.0 N.m (30-35 lb. in.).

8. Install 'O' ring (18) on plug (17) and thread in place. Torque to 39 N.m (28.7 lb. ft.).

9. Install washer (16) over poppet (17) with stamped sharp edge toward spring (14). Apply a heavy coat of petroleum jelly to the poppet end and install spring (14) and poppet together. The petroleum jelly will help keep the poppet from dropping during installation within the bore.

10. Insert spring (14), washer (16) and poppet as an assembly into cover with poppet in place within the seat.

NOTE

This completes assembly of the cover with the exception of the manual adjuster mechanism. Proceed to the appropriate manual adjuster mechanism used on your unit and assemble as shown.

11. Locknut Adjuster - Lubricate and assemble locknut adjuster parts in the reverse item number sequence. Install parts (9 through 2). See Figure 7. Torque adapter (5) to 100 N.m (73 lb. ft.).

12. Micrometer Knob - Refer to Figure 9 during the assembly.

a. Install back-up ring (21) and 'O' ring (20) within adapter (16). Lubricate seals with system fluid.

b. Insert adjusting pin (19) into adapter (16).

c. Install 'O' rings (18 & 17) on adapter (16) and thread in place within the cover. Torque to 100 N.m (73 lb. ft.).

NOTE

If spring (14), poppet (16) or seat (19) (Figure 7) were replaced, the pressure range of the valve will require calibration. DO NOT complete assembly of the knob until calibration is completed. If the original parts are being returned to service, calibration will not be required; proceed to the following step (d).

If calibration is required, thread adjustment rod (9) into adapter (16) until the rollpin hole located in the adjusting rod and adjusting pin are aligned. Install rollpin (6) and proceed to Section VII, Pressure Calibration.

d. Install scale (15) in place over 'O' ring (17). Make sure scale is oriented correctly.

e. Lubricate spring (14), ball (13) and ratchet plate (12) with petroleum jelly and install in place. Place retaining ring (11) over the ratchet plate and align rollpin holes. Insert rollpins (10) flush with outside surface of retaining ring. DO NOT press rollpins (10) past flush or the adjuster will bind.

f. Lubricate and thread adjustment rod (9) and bolt clockwise into adapter (16). Make sure tang of ratchet plate is in alignment with groove of adjustment rod. Thread adjustment rod in until rollpin hole of adjusting pin is in alignment with hole in adjustment rod. Install rollpin (6) into hole and center as shown in Figure 9 sectional view. Move the adjustment rod, the adjusting pin should rotate. This verifies correct alignment.

g. Install knob (2) and scale ring (3) as an assembly over bolt (4). Hold adjusting pin (19) and align rollpin hole (1) with opening in bolt (4). Install rollpin (1) flush with outside of knob (2).

13. Micrometer Knob with Keylock - Refer to Figure 9 during assembly.

a. Install back-up ring (21) and 'O' ring (20) within adapter (16). Lubricate seals with system fluid.

b. Insert adjusting pin (19) into adapter (16).

c. Install 'O' rings (18 & 17) on adapter (16) and thread in place within the cover. Torque to 100 N.m (73 lb. ft.).

NOTE

If spring (14), poppet (16) or seat (19) (Figure 7) were replaced, the pressure range of the valve will require calibration. DO NOT complete assembly of the knob until calibration is completed. If the original parts are being returned to service, calibration will not be required; proceed to the following step.

If calibration is required, thread adjustment rod (9) into adapter (16) until the rollpin hole located in the adjusting rod and adjusting pin are aligned. Install rollpin (6) and proceed to Section VII, Pressure Calibration.

d Install scale (15) in place over 'O' ring (17). Make sure scale is oriented correctly.

e. Lubricate spring (14), ball (13) and ratchet plate (12) with petroleum jelly and install in place. Place retaining ring (11) over the ratchet plate and align rollpin holes. Insert rollpins (10) flush with outside surface of retaining ring. DO NOT press rollpins (10) past flush or the adjuster will bind.

f. Lubricate and thread adjustment rod (9) into adapter (16). Make sure tang of ratchet plate is in alignment with groove of adjustment rod. Thread adjustment rod in until rollpin hole of adjusting pin is in alignment with hole in adjustment rod. Install rollpin (6) into hole and center as shown in Figure 8 sectional view. Move the adjustment rod, the adjusting pin should rotate. This verifies correct alignment.

g. Lock the keylock located within knob (2). Install knob (2) with keylock (5) and scale ring (3) over adjusting rod (9). Turn key to unlock and rotate knob until detent locks in place within the adjusting rod (less than a full turn). Install rollpin (7) in place flush with outside of knob (2). DO NOT press past flush or knob may bind. Lock knob, the knob should rotate freely in the locked condition.

Section VII - PRESSURE CALIBRATION

A. CALIBRATION ON A TEST STAND

NOTE

Modify an existing test stand or build up the stand shown in Figure 12. Prepare test blocks for the 16mm, 25mm and 40mm valves. Refer to Figure 13 for cartridge insert hole dimensions. Make sure the blocks have sufficient mass to handle the applied pressure.

1. Install cover subassembly on the test block and torque cover screws to the values shown in Table 9.

2. Turn off globe valve and set system relief to minimum pressure setting.

CAUTION

In the following step (3), if test stand capabilities are less than the maximum test pressure setting, adjust the system relief valve to an appropriate pressure just below test stand maximum.

3. Start-up the test stand and adjust system relief valve. DO NOT exceed the test stands pressure capability.

4. Open the globe valve and adjust cartridge relief valve under test to the maximum pressure setting as noted on the pressure gauge. Refer to Table 10 for cover pressure ranges (1 bar = 14.5 PSI). If the maximum setting is above the stands capability, adjust the cartridge relief valve to a pressure just below the test stands limit and perform steps 5 through 8. If the capability of the stand is not exceeded, omit steps 5 and 6 and perform steps 7 and 8.

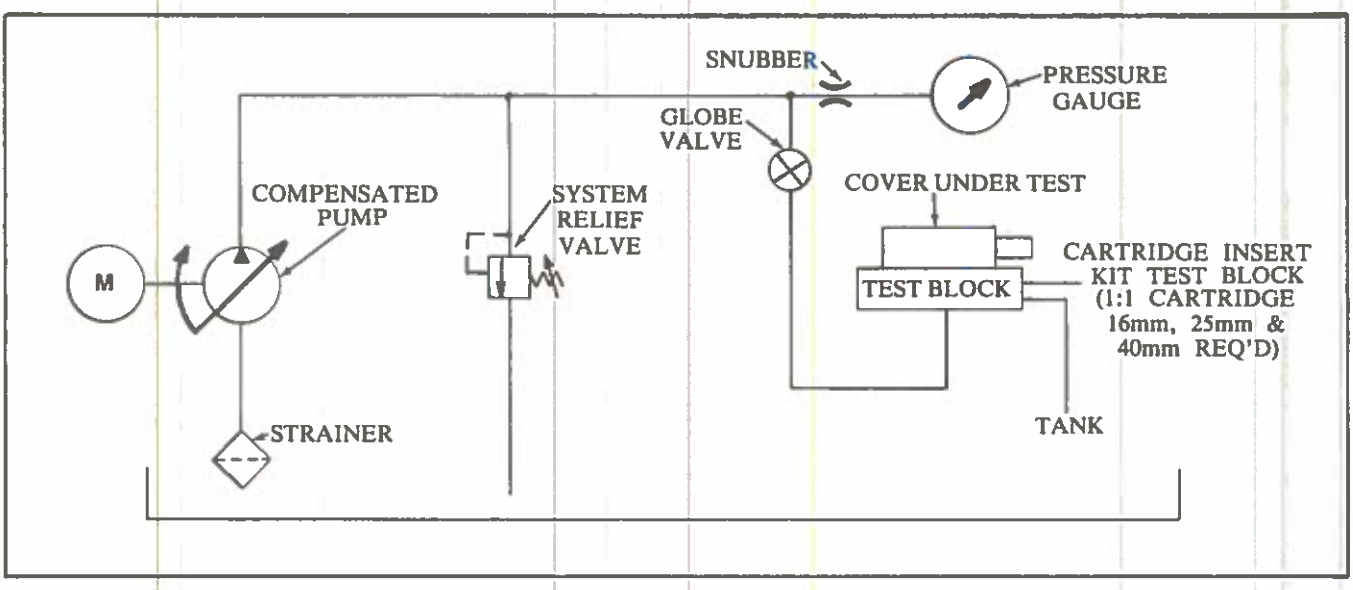


Figure 12. Test Stand

5. Reduce the cartridge valves pressure setting 1000 PSI and count the number of turns on the relief valve adjuster mechanism. This gives a relationship between pressure change and turns. Record this information and return the valves setting to the original pressure setting (just below test stand limit).

6. Rotate the valves adjuster mechanism clockwise until it bottoms out and count the number of turns. Use information recorded in previous step to determine the maximum setting of the valve. (i.e. if 10 turns = 1000 PSI change, then $\frac{1000}{10}$ equals 100 PSI/turn.

CAUTION

BE SURE to turn off the test stand and reduce pressure to zero before adjustment of the shims is accomplished in the following step.

7. Estimate the maximum pressure setting of the valve and adjust shims (13) Figure 7, accordingly. Adding shims increases pressure.

8. If the cartridge valve uses a micrometer knob or micrometer knob with keylock, return to the appropriate assembly procedure step, Section VI-I.12.d or VI-I.13.d. Remove rollpin (6) and adjusting rod (9). Complete assembly of the knob.

B. CALIBRATION ON THE MACHINE

WARNING

Before breaking a circuit connection, be certain that power is off and the system pressure has been relieved. Lower all vertical cylinders and block any load that could generate pressure.

1. Tee in a suitable pressure gauge at the outlet of the pump or at the inlet of the cartridge valve manifold.

2. Set the cartridge relief valve manual adjuster at minimum (fully counterclockwise) position.

3. Start-up the machine and read gauge pressure to be minimum.

4. Thread manual adjuster clockwise to the maximum pressure recommended for the system. Record the pressure.

5. Turn the manual adjuster counter-clockwise until pressure reduces 1000 PSI. Record the full number of revolutions of the manual adjuster. This gives an indication of the number of turns per 1000 PSI (i.e. $\frac{1000}{10}$ = 100 PSI/turn. This information can be used to estimate the maximum pressure range setting of the cartridge valve.

6. Turn the machine off, observe pressure gauge, it must go to zero (0) before adjustment of shims (13) Figure 7, is undertaken in the following step.

7. Turn the manual adjuster clockwise from the maximum pressure recommended for the system and count the turns required to bottom out. By using the number of turns per 1000 PSI calculated in step 5, an estimate of the maximum pressure setting of the valve can be determined. Remove or add shims (13) Figure 7. This will increase or decrease the pressure setting to cartridge relief valve specifications. See Tables 10, 12 and 13. NOTE: Adding shims increases pressure setting.

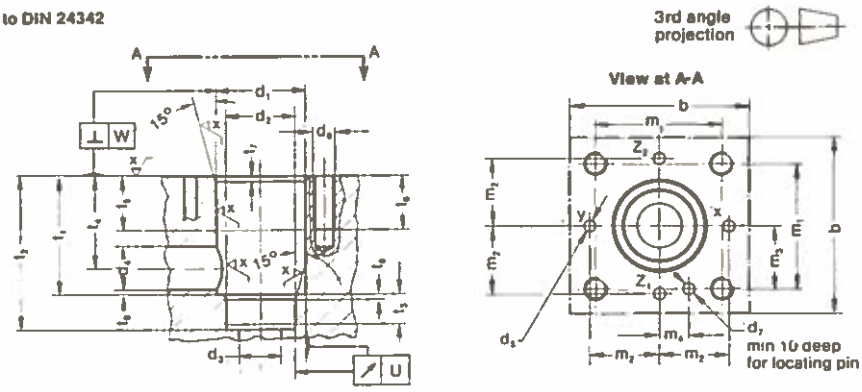
8. If the cartridge relief valve uses a micrometer knob or a micrometer knob with keylock, return to the appropriate step, Section VI-G.12.d or VI-G.13.d. Remove rollpin (6) and adjusting rod (9). Complete assembly of the knob.

C. CALIBRATION OF THE RELIEF VALVE MODULE ASSEMBLY

NOTE

The module pressure calibration procedures will follow exactly the procedures developed for ON TEST STAND and ON VEHICLE testing previously presented. Refer to Figure 10 during the adjustments.

Recess dimensions to DIN 24342



Dimension	Nominal size – metric (inches)		
	16	25	40
b	65 (2.56)	85 (3.35)	125 (4.92)
d_1	32,000 (1.2598) 32,025 (1.2608)	45,000 (1.7717) 45,025 (1.7726)	75,000 (2.9528) 75,030 (2.9539)
d_2	25,000 (0.9843) 25,021 (0.9851)	34,000 (1.3386) 34,025 (1.3396)	55,000 (2.1653) 55,030 (2.1665)
d_3 max.	16 (.63)	25 (.98)	40 (1.57)
d_4	16 (.63)	25 (.98)	40 (1.57)
d_4 max.	25 (.98)	32 (1.26)	50 (1.97)
d_5 max.	4 (.157)	6 (.236)	10 (.393)
d_6 Thread	M8 (.3125-18)	M12 (.500-13)	M20 (.750-10)
d_7	4,000 (.1575) 4,180 (.1646)	6,000 (.2362) 6,180 (.2433)	6,000 (.2362) 6,180 (.2433)
m_1 $^{\pm 0.2\ (\pm .008)}$	46 (1.811)	58 (2.284)	85 (3.347)
m_2 $^{\pm 0.2\ (\pm .008)}$	25 (.984)	33 (1.296)	50 (1.969)
m_3 $^{\pm 0.2\ (\pm .008)}$	23 (.906)	29 (1.142)	42,5 (1.674)
m_4 $^{\pm 0.2\ (\pm .008)}$	10,5 (.414)	16 (.630)	23 (.906)
t_1 $^{+0.1\ (+.004)}$	43 (1.692)	58 (2.283)	87 (3.425)
t_2 $^{+0.1\ (+.004)}$	56 (2.204)	72 (2.834)	105 (4.133)
t_3 *	11 (.433)	12 (.472)	15 (.590)
t_4	34 (1.338)	44 (1.732)	64 (2.519)
t_4 to d_4 max.	29.5 (1.161)	40.5 (1.594)	59 (2.322)
t_5 *	20 (.787)	30 (1.181)	30 (1.181)
t_6 Thread Depth	20 (.787)	25 (.984)	35 (1.377)
t_7	2 (.078)	2.5 (.098)	3 (.118)
t_8	2 (.078)	2.5 (.098)	3 (.118)
t_9	1.5 (.059)	1.5 (.059)	3 (.118)
U	0,03 (.0012)	0,03 (.0012)	0,05 (.0020)
W	0,05 (.002)	0,05 (.002)	0,1 (.0039)
x_{Ra}	1,6 micrometre (63 microinches)		

* Depth of finish = x_{Ra} in hole.

Figure 13. Test Block Cartridge Insert Recess Dimensions (Metric)

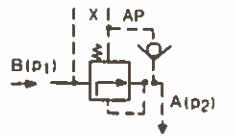
Litho in U. S. A.

Printed in U.S.A.

CARTRIDGE VALVES

MODEL SERIES CVI/CVC/CVGC

FOR PRESSURE REDUCING FUNCTIONS



STANDARD GRAPHICAL SYMBOL FOR FLUID POWER DIAGRAMS

GENERAL DATA

The basic pressure reducing cartridge arrangement features manual adjustment of reduced pressure plus a pilot port for optional remote control. Additional feature options include electrical selection of high and low pressures and electrohydraulic proportional control of reduced pressure.

The cartridge insert fits into a DIN 24342 recess and consists of a sleeve, a spool subassembly and a closing spring. The spool incorporates a check valve that allows any outlet port pressure peaks to be limited by the internal pilot pressure control.

A cover, containing a pressure adjustment and all piloting connections, retains the cartridge in its recess. It also includes a pressure compensated flow control that ensures near-constant pilot flow irrespective of system pressures. An alternative cover also has a mounting surface, based on NFPA-D01, that accepts other pilot control options.

The reducing valve arrangements described in this bulletin can be built into system manifold assemblies with directional, manually adjustable flow restrictor and pressure relief functions in cartridge form.

RATINGS

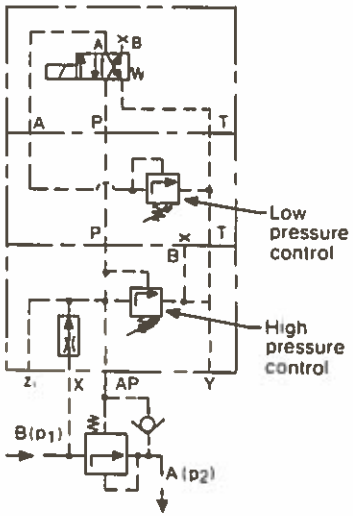
Nominal Sizes	16mm and 25mm
Maximum Operating Pressure	350 Bar
Maximum Flow Rate (Δp = 14 Bar)	Up to 400 l/min (106 GPM)
Pressure Adjustment Ranges	5 to 125 Bar 5 to 245 Bar 5 to 350 Bar

FUNCTIONAL SYMBOLS

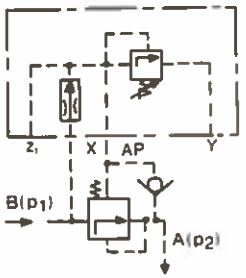
Typical constructions are symbolized here and shown on pages 5 to 7.

Note that in all cases:
z_1 = Pilot port for remote hydraulic control. Block externally when not required.

Y = Pilot relief exhaust.



Dual-level reduced pressure functions by electrical and spring offset selection.



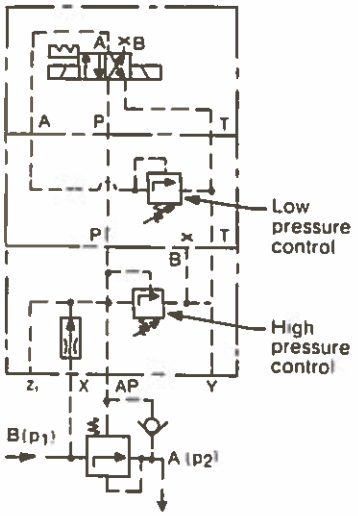
Pressure reducing function with manual adjustment and remote control port.

OPERATING DATA

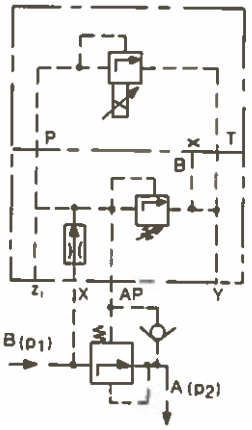
Unless otherwise stated, performances are based on mineral oil at 25 cSt and at 50°C (120°F).

Maximum Operating Pressure

Ports A, B and X . Up to 350 Bar (5000 PSI)
All other ports . . . Up to 350 Bar (5000 PSI)
dependent on limits for relevant ports in any associated pilot valves or modules. Note that any pressure in port "Y" is additive to the setting(s) of the integral pilot pressure control(s).



Dual-level reduced pressure functions by electrical selection with mechanical detent.



Pressure reducing function by electrohydraulic proportional control.

Maximum Flow Rates

Through main ports in controlled flow direction.

16mm .....200 l/min
25mm .....400 l/min

Pressure Drop/Flow Data

Curve No.	Inlet Pressure	Pressure Adjustment Range (Bar)
A	350	5-350
B	200	5-245
C	200	5-125
D	200	5-245
E	350	5-350
F	350	5-350

1 Bar = 14.5 PSI

CONTROL DATA

Pressure Reducing Function With Manual Adjustment And Remote Control Port

Adjustment is located in the control cover. Adjustment options are shown on pages 5-7, and described on page 3. Pilot port (z_1) is provided for optional remote control by suitable pilot pressure control valve(s) with or without pilot selector valves. Suitable pilot pressure controls are the C-175 and CGR-02 valves. Pilot selector valves for multi-level reduced pressure selection can be from the DG4V, DG17V and DG20V solenoid, manually or mechanically controlled directional valve ranges respectively. These can remotely simulate the type of compact arrangement shown on page 6 and described below.

Dual-Level Reduced Pressure Function By Electrical Selection

Alternative arrangements utilizing either a DG4V-3-2A-LH single solenoid spring-offset or DG4V-3-2N double solenoid two-position detented pilot selector together with a pilot pressure module for low reduced pressure setting are illustrated on page 6. For details of the DG4V-3 series valves, see Vickers installation drawing 517351.

Pressure Reducing Function By Electrohydraulic Proportional Control

A CGE-02 electrically operated proportional relief valve is incorporated to control the reduced pressure in proportion to the applied electrical current. The manual adjustment in the control cover can be set to limit the maximum reduced pressure, while pilot port z_1 provides the same remote control possibilities described for the other arrangements above.

The pressure reducing function by electrohydraulic proportional control is symbolized on cover page, and illustrated on page 7. Additional information about the CGE-02 valve is provided in installation drawing 511050. For further details, consult your Vickers representative.

HYDRAULIC FLUIDS

All valves can be used with anti-wear hydraulic oils, water-in-oil emulsions, water glycols and certain low viscosity fluids.

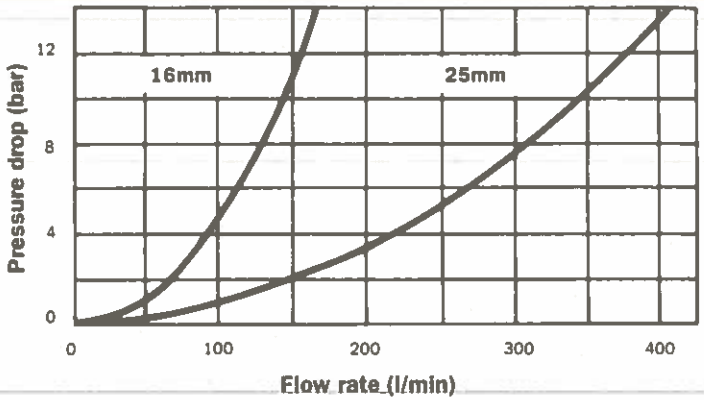
Note:
Add prefix "F3" to model designations of electrically operated pilot valves and order cartridge and module assemblies by special kit numbers, obtainable from Vickers when phosphate ester (not alkyl-based) or chlorinated hydrocarbons are to be used.

The extreme viscosity range is from 500 to 5 cSt but the recommended range is from 54 to 5 cSt. Consult Vickers if the minimum viscosity will be less than 13 cSt.

For further information about fluids, see Vickers data sheet I-286-S, "Hydraulic Fluid and Temperature Recommendations for Industrial Machinery" (included in the Technical Information section of Vickers Catalog 400).

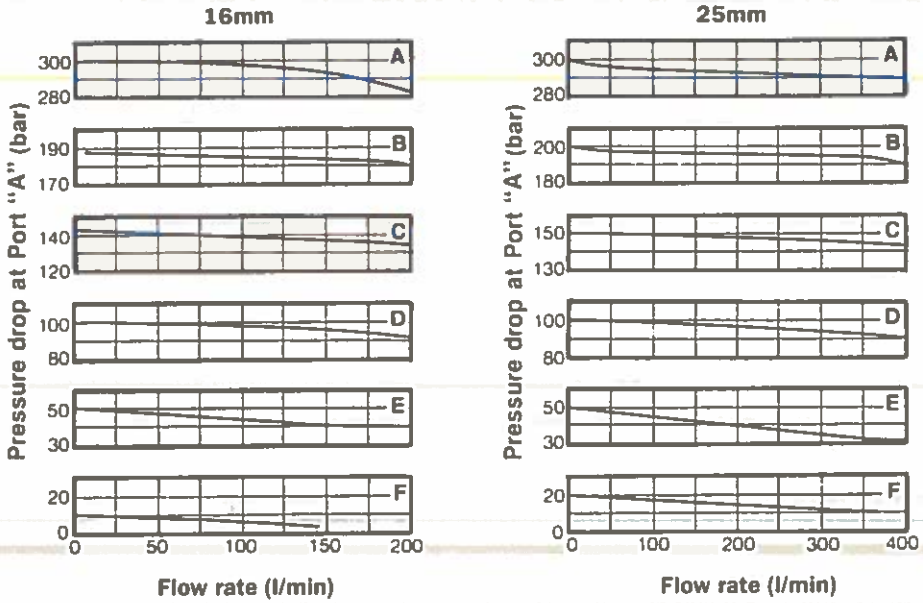
Pressure Drop/Flow Data

Through main ports in controlled flow direction (valve held fully open).



Pressure Drop/Flow Data

Through main ports in controlled flow direction at various combinations of inlet pressure and reduced pressure.



TEMPERATURE LIMITS

Ambient

Minimum ..... −10°C(14°F)
Maximum ..... +70°C(160°F)

Fluid Temperature

Mineral Oil
Minimum ..... −10°C(14°F)
Maximum* ..... +80°C(180°F)

Water Containing
Minimum ..... +10°C(50°F)
Maximum* ..... +54°C(130°F)

* To obtain optimum service life from both fluid and hydraulic system, 65°C(150°F) is normally the maximum temperature except for water-containing fluids.

For synthetic fluids consult manufacturer or Vickers representative where limits are outside those for mineral oil. Whatever the actual temperature range, ensure that viscosities stay within the limits specified in the "Hydraulic Fluids" section.

FILTRATION REQUIREMENTS

Adequate fluid filtration for protection from environmental contaminant ingression and generated contaminants must be provided to ensure reliable system performance and long service life.

For cartridge valves, 10-micrometer elements can be used to maintain most systems at an ISO cleanliness code of 18/13. This protection can be provided by Vickers OFP pressure filters and OFR or OFRS return line filters.

Refer to Section "P"-"Filters" and Section "S"-"Technical Information" of Vickers Catalog 400, or contact your Vickers representative for further filtration advice.

WEIGHT

Cartridge and Pilot Valve Arrangements	Kg(Lbs.)	
	16mm	25mm
As page 5	2.0 (4.4)	2.8 (6.2)
As page 6, with DG4V-3-2A-LH pilot valve	—	5.8* (12.8)
As page 6, with DG4V-3-2N pilot valve	—	6.2* (13.6)
As page 7, with CGE-02 electrohydraulic relief valve	—	4.2* (9.2)

* Plus pilot valve fixing bolts.

MOUNTING ATTITUDE

Unrestricted for all arrangements without directional control valves.

No-spring detented ("N" spool/spring arrangement) directional controls must be horizontal but other versions may be at any attitude although horizontal installation is preferred.

ORDERING PROCEDURE

Ask your Vickers representative for a quotation on a cartridge valve system tailored to your application, or quote the appropriate model code numbers in this brochure.

Note:
Solenoid operated directional pilot valve and fixing bolt kit to be ordered and supplied as separate items.

Pressure Reducing Function With Manual Adjustment and Remote Control Port

Adjustment Arrangement CVC-**-X-S2-□-***-10		Adjustment Range (Bar)					
		(16mm)			(25mm)		
		5-125	5-245	5-350	5-125	5-245	5-350
Micrometer Knob	M	580342	580343	580344	580385	580386	580387
Micrometer Knob With Key-Lock	K	580345	580346	580347	580388	580389	580390
Set Screw, Locknut and Cap	W	580336	580337	580338	580379	580380	580381
Use Above Covers With Pressure Reducing Insert CVI-**-X1-2-10		580360			580421		

Dual-Level Reduced Pressure Functions By Electrical Selection

Adjustment Arrangement CVC-**-X1-S2-□-***-10		25mm					
		Adjustment Range (Bar)					
		Pressure Reducing Cover			Pressure Control Module		
		5-125	5-245	5-350	5-125	5-245	5-350
Micrometer Knob	M	580394	580395	580396	580076	580077	580092
Micrometer Knob With Key-Lock	K	580397	580398	580399	580261	580323	580324
Set Screw, Locknut and Cap	W	580391	580392	580393	580031	580032	580033
Use Above Covers With Pressure Reducing Insert CVI-**-X1-2-10		580421					

Pressure Reducing Function By Electrohydraulic Proportional Control

Adjustment Arrangement CVC-**-X1-S2-W-***-10		25mm		
		Adjustment Range (Bar)		
		5-125	5-245	5-350
Set Screw, Locknut and Cap	W	580391	580392	580393
Use Above Covers With Pressure Reducing Insert CVI-**-X1-2-10		580421		

Note:
Electrically operated proportional relief valve and fixing bolt kit to be ordered and supplied as separate items.

MODEL CODE
Inserts

F* - CVI - 16 - X1 - 2 - ■ - 10 - ■ - ■

1 2 3 4 5 6 7 8 9

1 Special Seals

See "Hydraulic Fluids" note, page 2.

2 Cartridge Valve Insert

3 Valve Size

16 - 16mm
25 - 25mm

4 Function

X1 - Reducer open

5 Seals

1 - DIN 3770 (Europe)
2 - ISO 3601 (Europe and USA)
3 - JIS B2401 (Japan)

6 Spring

Blank - Omit

7 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

8 Model Suffix

For special features.

9 Orifices

Blank - Omit

MODEL CODE
Modules

F* - CVGC - 3 - W - 125 - 10

1 2 3 4 5 6

1 Special Seals

See "Hydraulic Fluids" note, page 2.

2 Cartridge Valve Module

3 Size (Interface)

3 - CETOP RP35H Size 3
NFPA D01 (ISO 4401)

4 Pressure Adjustment Method

W - Screw locknut
M - Micrometer
K - Micrometer with key

5 Pressure Range

125 - 5 to 125 bar
250 - 5 to 250 bar
350 - 5 to 350 bar

6 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

MODEL CODE
Covers

F* - CVC - 16 - X - S2 - M - 125 - 10 - ■ - ■

1 2 3 4 5 6 7 8 9 10

1 Special Seals

See "Hydraulic Fluids" note, page 2.

2 Cartridge Valve Cover

3 Valve Size

16 - 16mm
25 - 25mm

4 Function

X - Reducer
X1 - Reducer, NFPA D01 (with inch threads), 25 mm only.

5 Seals, Plugs, Bolts

(S2, B19, B29, etc.)
Codes

For Plugs:
B - BSP thread (Europe)
S - SAE thread (USA)
For Seals:
1 - DIN 3770 (Europe)
2 - ISO 3601 (Europe and USA)
3 - JIS B2401 (Japan)
For Bolts:
9 - With metric bolts (Europe)
Blank - Without any bolts (USA)

6 Adjustment Device

M - Micrometer
K - With key lock
W - With locknut

7 Pressure Range

125 - 125 bar
245 - 245 bar
350 - 350 bar

8 Design Number

Subject to change. Outside dimensions remain as shown for numbers 10 through 19.

9 Model Suffix

For special features.

10 Orifices

Omit if basic.
Deviations in location or size should be specified, e.g. "no orifice in AP port; 1.2mm orifice in Z2" should be coded "AP99-Z212" (see code below).

Codes
Pilot ports are X, Y, Z1, Z2, and AP.
08 — 0.8mm orifice
14 — 1.4mm orifice
99 — No orifice
00 — Plug

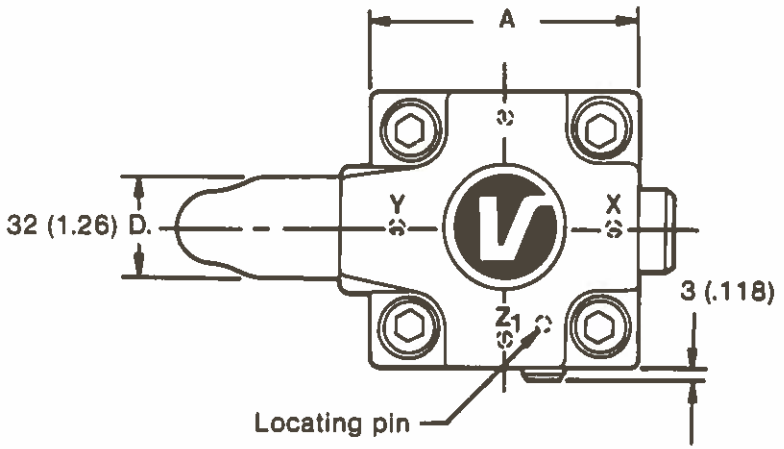
Examples
X08 — Orifice 0.8mm in port X.
Z112 — Orifice 1.2mm in port Z1.
Y99 — No orifice in port Y.
Z200 — Plug in port Z2.

INSTALLATION DIMENSIONS

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
16mm	.312-18 x 1.50	BKDNG16-702	26
25mm	.500-13 x 1.50	BKDPNG25-704	81

NOTE: All cover bolts are UNC, grade 8 or better.



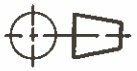
Dimensions - mm (in.)

Nominal Size	A	B	C	D max.	F	G	H	J
16mm	65 (2.55)	46 (1.81)	26 (1.02)	137.0 (5.39)	114.5 (4.50)	154.5 (6.08)	10 (.39)	57 (2.24)
25mm	85 (3.34)	51 (2.00)	26 (1.02)	127.5 (5.01)	105.0 (4.13)	145.5 (5.72)	10 (.39)	66 (2.60)

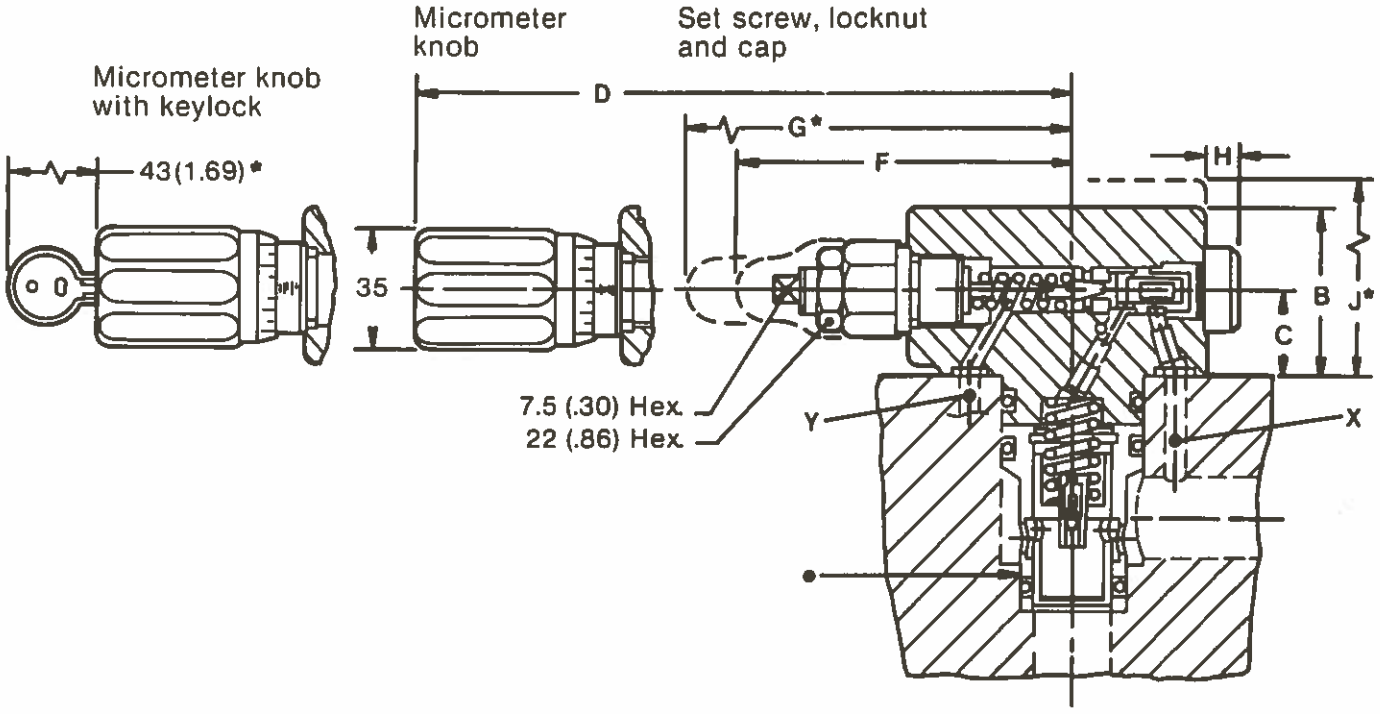
Pressure Reducing Function With Manual Adjustment and Remote Control Port

Sizes 16mm and 25mm

Dimensions Shown In Millimeters and (Inches)



3rd Angle Projection



* Maximum for withdrawal

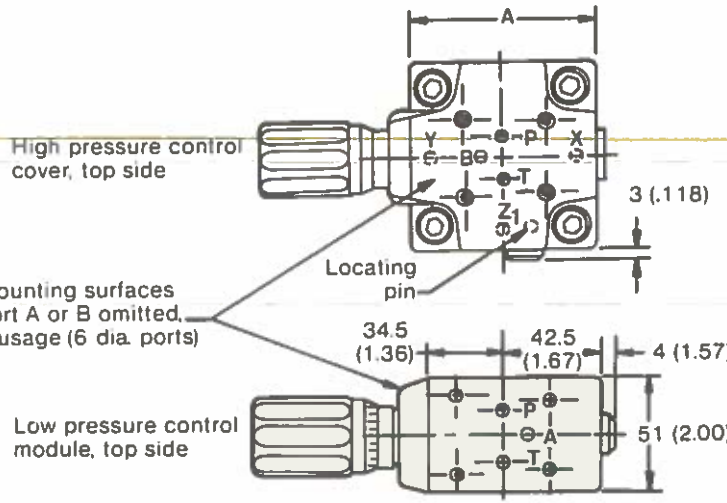
● For recess dimensions, see page 8.

519205-5

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
25mm	.500-13 x 1.50	BKDPNG25-704	81

NOTE: All cover bolts are UNC, grade 8 or better.

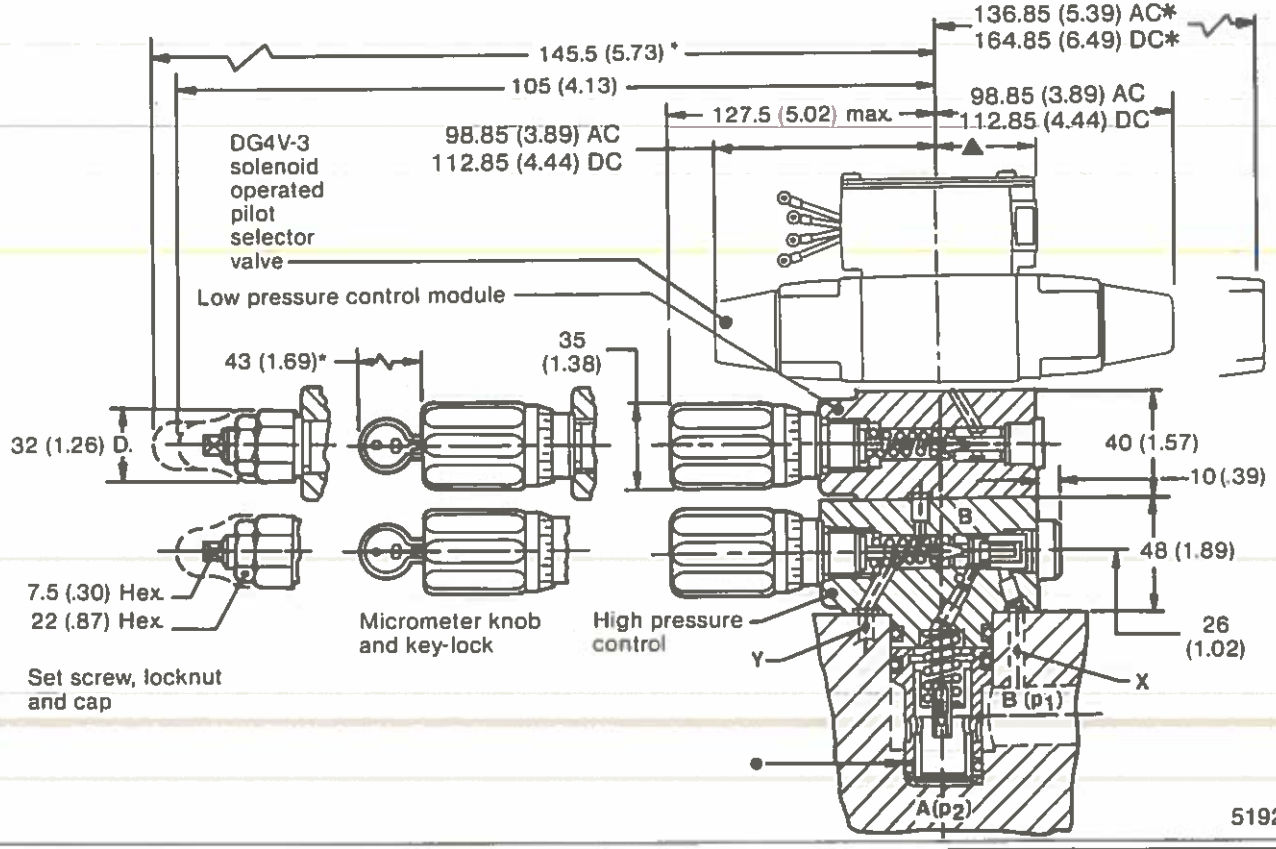

A
High pressure control cover, top side
3 (.118)
Locating pin
NFPA-D01 mounting surfaces with either port A or B omitted, according to usage (6 dia. ports)
34.5 (1.36)
42.5 (1.67)
4 (1.57)
Low pressure control module, top side
51 (2.00)

Dual-Level Reduced Pressure Functions By Electrical Selection

Size 25mm

Dimensions Shown in Millimeters And (Inches)

3rd Angle Projection



* Clearance to remove solenoid coil.

● For recess dimensions, see page 8.

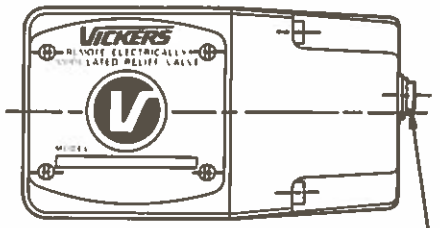
▲44 (1.7) for DG4V-3-2A-LH (single solenoid models)

519205-6

Bolt Kit Ordering Number and Recommended Cover Fixing Bolt Torque

Cover Size	Bolt Size	Order Number	Torque Ft. Lb.
25mm	.500-13 x 1.50	BKDPNG25-704	81

NOTE: All cover bolts are UNC, grade 8 or better.



Factory Pre-Set Minimum Pressure Adjustment Access Screw.

Pressure Reducing Function By Electrohydraulic Proportional Control

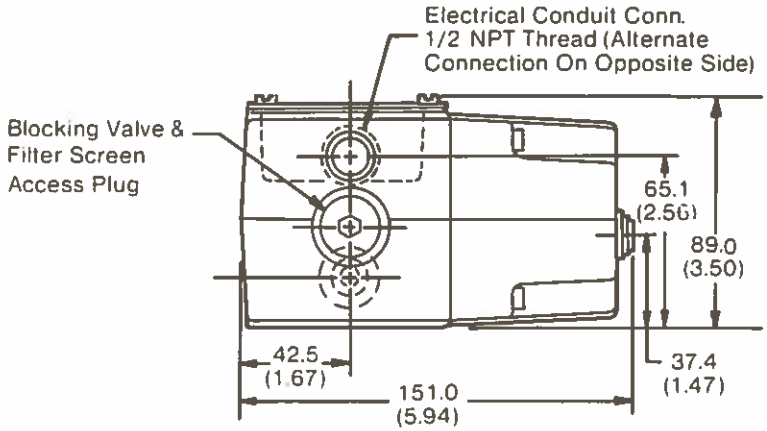
Size 25mm

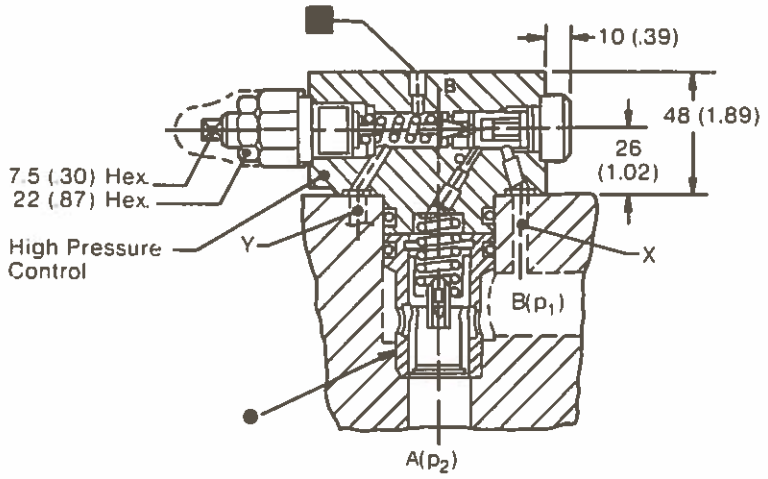
Dimensions Shown In Millimeters and (Inches)

3rd Angle Projection

* For recess dimensions, see page 8.

■ "B" port must be plugged in cover when using the CGE-02 remote electrical pressure control valve.


Electrical Conduit Conn. 1/2 NPT Thread (Alternate Connection On Opposite Side)
Blocking Valve & Filter Screen Access Plug
65.1 (2.56)
89.0 (3.50)
42.5 (1.67)
37.4 (1.47)
151.0 (5.94)

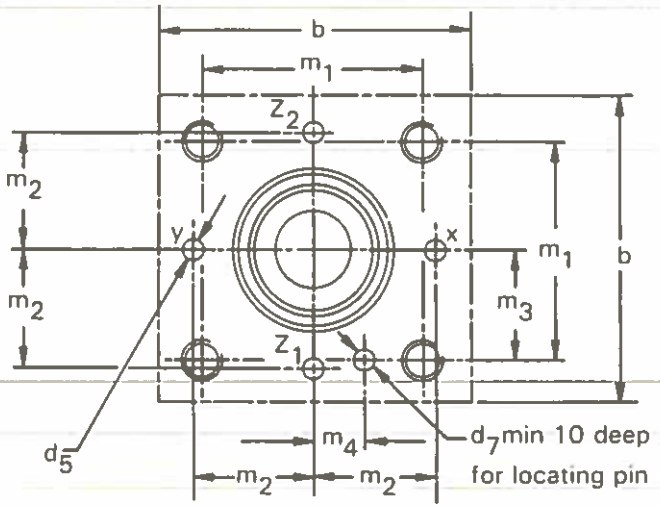


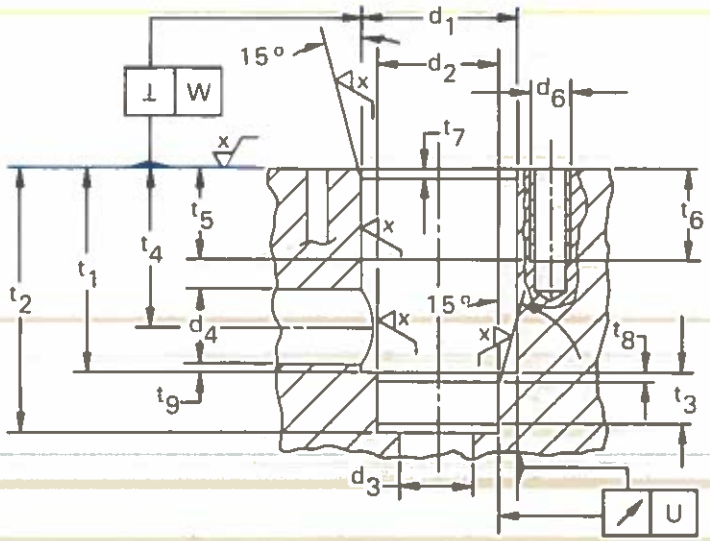
Recess Dimensions To DIN 24342

Dimension	Nominal Size - Metric (Inches)	
	16mm	25mm
b	65 (2.56)	85 (3.35)
d_1	32.000 (1.2598) 32.025 (1.2608)	45.000 (1.7717) 45.025 (1.7726)
d_2	25.000 (0.9843) 25.021 (0.9851)	34.000 (1.3386) 34.025 (1.3396)
d_3 maximum	16 (.63)	25 (.98)
d_4	16 (.63)	25 (.98)
d_4 maximum	25 (.98)	32 (1.26)
d_5 maximum	4 (.157)	6 (.236)
d_6 Thread	M8 (.3125-18)	M12 (.500-13)
d_7	4.000 (.1575) 4.180 (.1646)	6.000 (.2362) 6.180 (.2433)
m_1 ±0.2(±.008)	46 (1.811)	58 (2.284)
m_2 ±0.2(±.008)	25 (.984)	33 (1.299)
m_3 ±0.2(±.008)	23 (.906)	29 (1.142)
m_4 ±0.2(±.008)	10.5 (.414)	16 (.630)
t_1 +0.1(+.004)	43 (1.692)	58 (2.283)
t_2 +0.1(+.004)	56 (2.204)	72 (2.834)
t_3*	11 (.433)	12 (.472)
t_4	34 (1.338)	44 (1.732)
t_4 to d_4 maximum	29.5 (1.161)	40.5 (1.594)
t_5*	20 (.787)	30 (1.181)
t_6 Thread Depth	20 (.787)	25 (.984)
t_7	2 (.078)	2.5 (.098)
t_8	2 (.078)	2.5 (.098)
t_9	1.5 (.059)	1.5 (.059)
U	0.03 (.0012)	0.03 (.0012)
W	0.05 (.002)	0.05 (.002)
X_{Ra}	1.6 micrometer (63 microinches)	

*Depth of finish "X_{Ra}" in hole.

Recess Dimensions To DIN 24342



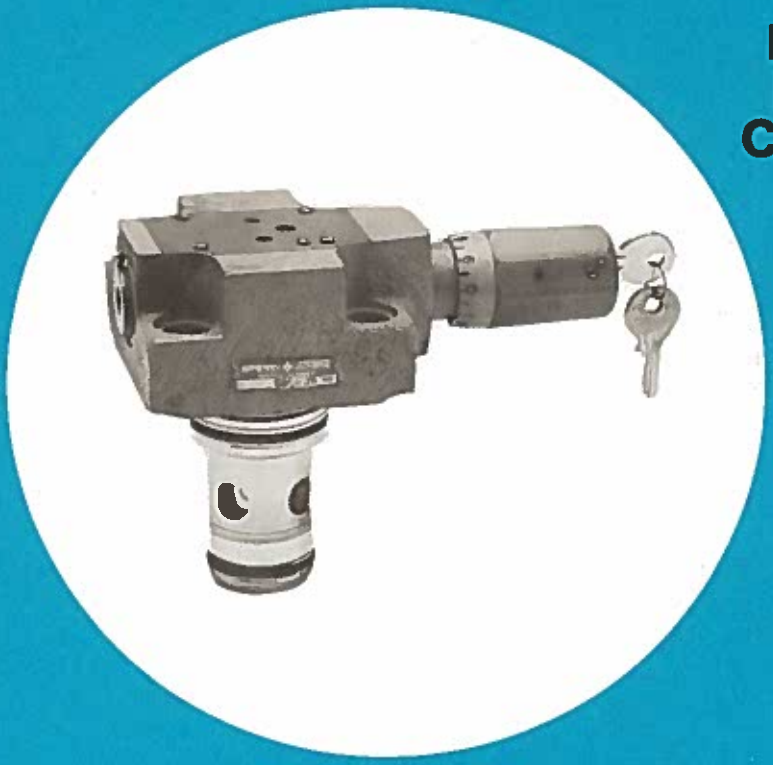


519205-8

SPERRY VICKERS

28

PRESSURE REDUCING CARTRIDGE VALVES



OVERHAUL MANUAL

CVC-16/25-X(1)-S2-*-* * *-10 **COVER**

CVI-16/25-X-2-10 **INSERT**

Revised 6-1-84

SPERRY VICKERS, TROY, MI 48084
VICKERS, INCORPORATED, IS A SUBSIDIARY OF SPERRY CORPORATION
SPERRY VICKERS IS A REGISTERED TRADEMARK OF SPERRY CORPORATION

I-3640-S

TABLE OF CONTENTS

SECTION		PAGE
I	INTRODUCTION	
	A. Purpose of Manual	1
	B. General Information	1
	C. Model Codes	1
II	DESCRIPTION	
	A. General	2
	B. Valve Construction	2
III	PRINCIPLES OF OPERATION	
	A. Standard Pressure Reducing Valve	3
	B. Model Variations with NFPA-D01/ISO-4401-3 Interface Cover	3
IV	INSTALLATION AND OPERATING INSTRUCTIONS	
	A. Installation Drawings	7
	B. Mounting	7
	C. Piping & Tubing	7
	D. Hydraulic Fluid Recommendations	7
	E. Overload Protection	7
	F. Replacement Parts	7
	G. Product Life	7
	H. Troubleshooting	7
V	SERVICE AND MAINTENANCE	
	A. Service Tools	8
	B. Inspection	8
	C. Adding Fluid to System	8
	D. Adjustments	8
	E. Lubrication	8
VI	OVERHAUL	
	A. Cover Removal	8
	B. Subassemblies Available for Cartridge Pressure Reducing Valves with Standard Covers	11
	C. Removal of Adjuster Mechanisms from Cover	11
	D. Removal of Standard and Interface Cover Parts	12
	E. Disassembly of Low Pressure Module	13
	F. Removal of Cartridge Insert from Manifold	13
	G. Subassemblies Available for Cartridge Valves with Interface Covers	14
	H. Inspection Repair and Replacement	15
	I. Cartridge Valve Assembly	15
VII	PRESSURE CALIBRATION	
	A. Calibration on a Test Stand	16
	B. Calibration on the Machine	16
	C. Calibration of Pressure Reducing Valve Module	19

A. PURPOSE OF MANUAL

This manual describes basic operation characteristics and provides service and overhaul information for Sperry Vickers cartridge type pressure reducing valves.

B. GENERAL INFORMATION

Related Publications - Installation dimensions are not contained in this manual. Cartridge valve installation drawings are listed in Table 1. Installation drawings are available from any Sperry Vickers engineering office or from:

Sperry Vickers
Technical Publications
1401 Crooks Road
Troy, MI 48084

VALVE TYPE	INSTALLATION DRAWINGS	
	16mm	25mm
Pressure Reducing Valve	Installation information is shown in advertising brochure "318".	

Table 1. Related Publications

C. MODEL CODES

The model code, Table 2a, depicts cover variables.

The model number stamped into the cover nameplate does not identify the cartridge valve insert. To identify standard cartridge insert parts, refer to Section I-B-2 and Table 11, of this manual. The cartridge insert model code is shown in Table 2b.

MODEL CODE BREAKDOWN

CVC - ** - ** - S2 - * - * - 10 - ***

- CVC: Cartridge Valve Cover
- **: Valve Size (mm) -16, -25
- **: Function X - Reducing; X1 - NFPA-D01/ISO-4401-3 Interface Cover (25mm)
- S2: S = SAE Thread Plugs; 2 = ISO 3601 Seals
- *: Adjustment Devices -M - Micrometer Knob; -K - Micrometer Knob with Keylock; -W - Locknut
- ***: Pressure Range (bar) 125 5-125 bar; 245 5-245 bar; 350 5-350 bar
- 10: Design Number
- ***: Model Suffix

Table 2a. Cover Model Code Breakdown

MODEL CODE BREAKDOWN

CVI - ** - * - 2 - 10 - *

- CVI: Cartridge Valve Insert
- **: Valve Size (mm) -16, -25
- *: Function X - Reducing Open
- 2: Seals 2 - ISO 3601
- 10: Design Number
- ***: Model Suffix

Table 2b. Cartridge Valve Insert Model Code Breakdown

A. GENERAL

Cartridge pressure reducing valves are constructed in two sections. One section is called the cover section which contains the pilot mechanisms for controlling pressure. The other section is a cartridge valve insert section. Nominal sizes of 16mm and 25mm are available.

Cover parts vary according to valve size and the type of adjuster. The following adjusters are available (see Table 3). An exploded view showing item numbers for disassembly and assembly sequence can be found in Section VI.

MANUAL ADJUSTER TYPE	FIGURE NO.
With Locknut	7
With Micrometer Knob	9
With Micrometer Knob & Key	9

Table 3. Location of Adjuster Exploded Views

B. VALVE CONSTRUCTION

NOTE
Cartridge pressure reducing valve covers are mounted to the manifold with four (4) cap screws. The cover retains the valve insert within the manifold cavity.

1. Standard Covers - The cover S/A contains the pressure reducing valve pilot stage (head) consisting of a seat, poppet, spring, flow control, seals, and the adjuster mechanism (see Figure 1).

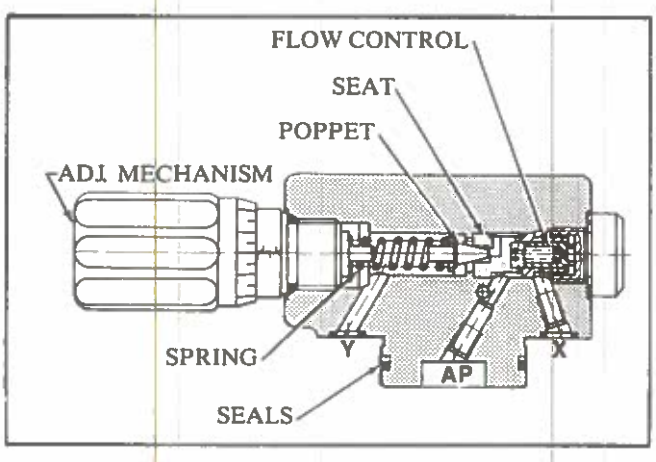


Figure 1. Pressure Reducing Valve Pilot Stage Head

2. Cartridge Insert Construction - Cartridge pressure reducing valve inserts are constructed as shown in Figure 2. The entire cartridge insert is placed within a manifold designed and drilled to provide the necessary port openings and operating circuit. Each cartridge valve insert is comprised of a sleeve, spool S/A, spring and associated seals.

a. The sleeve contains 'O' ring grooves, port openings and a retaining ring to limit the downward travel of the spool S/A.

b. The standard spool S/A area ratio is 1:1. This means that the outside diameter (O.D.) of the spool is the same throughout its length. A check valve is incorporated within the spool to limit pressure transients in the load.

c. When outlet pressure is below poppet cracking pressure, the spring holds the spool against the retaining ring and port (B) is open to the load (A).

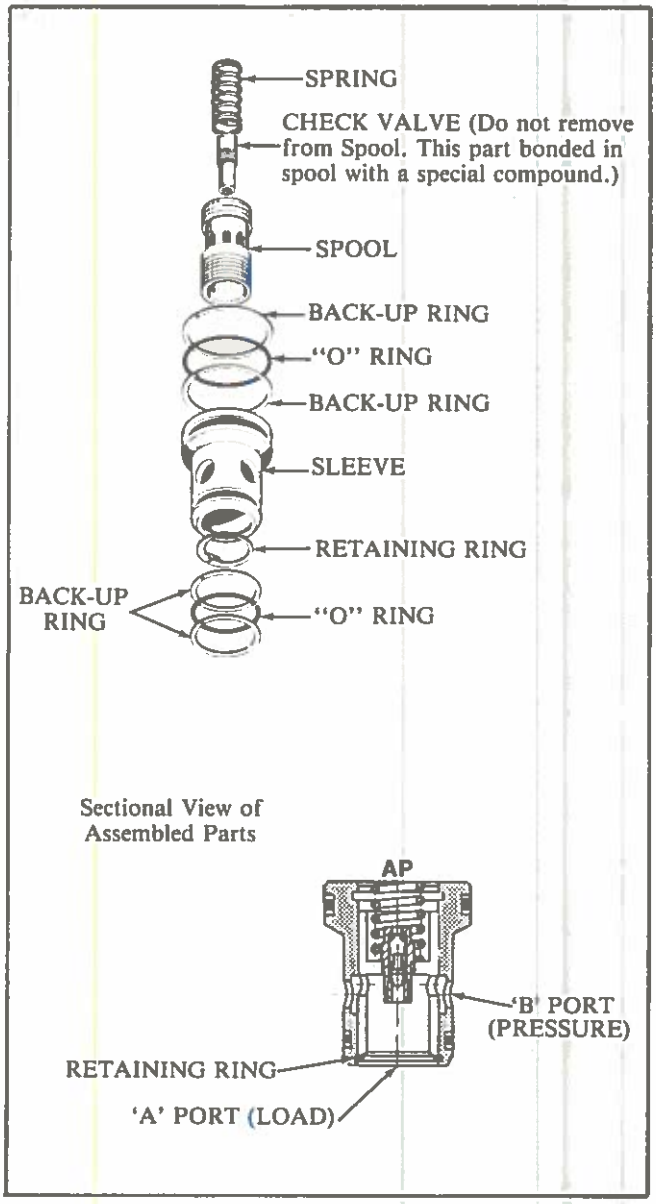


Figure 2. Cartridge Insert Kit Exploded and Sectional Views

A. STANDARD PRESSURE REDUCING VALVE OPERATION

Figure 3 illustrates valve operation. The pressure setting of the valve is determined by the position of the adjusting screw which varies spring compression. Spring force determines poppet cracking pressure.

In normal operation, the 'A' port is connected to the load and the 'B' port is connected to the pressure source. The 'B' and 'X' ports are interconnected within the manifold. System pressure at 'B' is fed to the 'X' port and communicated through a compensated flow control into area AP. The flow control in the cover establishes a flow across the cover poppet at poppet cracking pressure. With poppet cracking pressure above the spool S/A, a pressure which exceeds poppet cracking pressure and the spring force must be developed in the load before the spool S/A can move upward (see Figure 3).

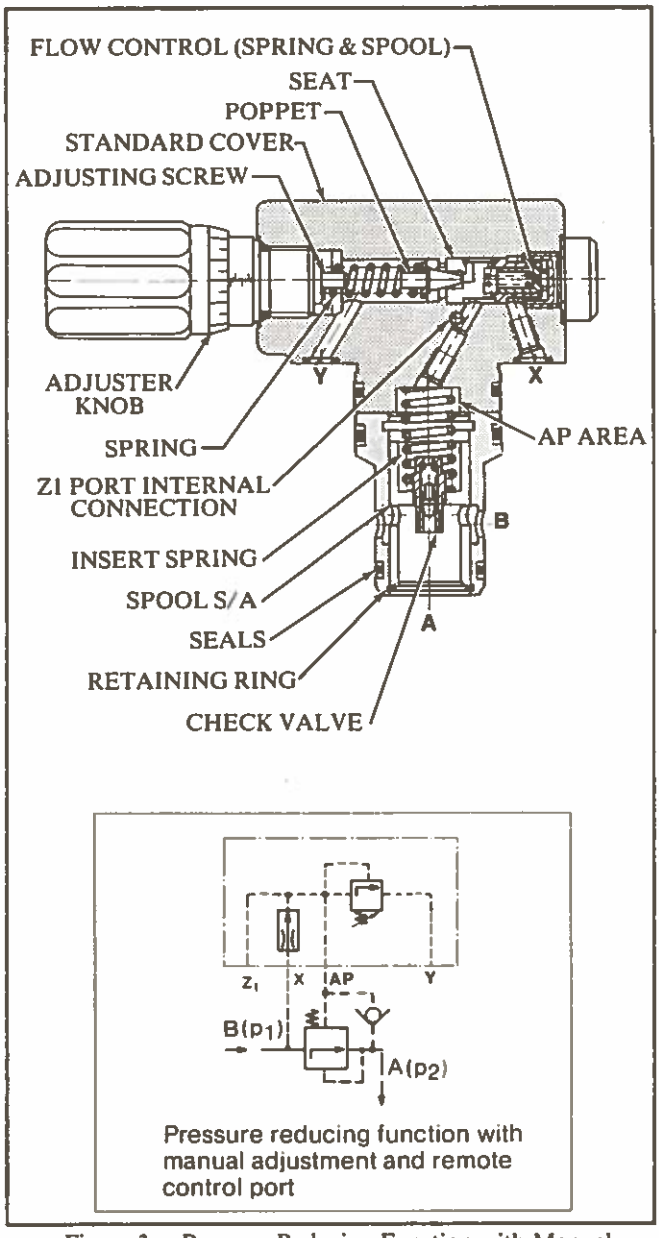


Figure 3. Pressure Reducing Function with Manual Adjustment and Remote Control Port

As load pressure at 'A' rises, a point is reached that causes the spool S/A to move upward and flow is restricted to the load.

If load pressure drops below poppet cracking pressure, the insert spring moves the spool S/A downward while the flow control replenishes fluid volume above the spool S/A. The spool S/A then meters flow to the load, raising outlet pressure again to poppet cracking pressure.

NOTE
A pressure reducing valve varies flow to provide constant outlet pressure.

Pressure transients in the load are relieved through a check valve located within the spool S/A.

Venting of the Z1 port will cause outlet pressure to drop to the minimum pressure setting.

B. MODEL VARIATIONS USING THE NFPA-D01/ISO-4401-3 INTERFACE COVER

NOTE
Various other cartridge pressure reducing valve configurations exist. These valves function similar to the basic pressure reducing valve with the exceptions noted in the following paragraphs.

1. Pressure Reducing High and Low Adjustable Settings by Electrical and Spring Offset Selection (see Figure 4)

In this configuration a left hand spring offset directional valve controls two reducing valve heads and provides two different reduced pressures.
The highest pressure setting is controlled by the pilot valve located in the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. When the (LH) spring offset valve is in the offset condition (solenoid de-energized), the high pressure setting is active. Provide at least 10.3 bar (150 PSI) spread between the high and low pressure settings to prevent interaction.

Use a standard spring offset valve (offset to 'A') to have the low pressure setting functional in the spring offset condition. If a standard valve is used, check installation dimensions to make sure a problem does not exist. The standard valves solenoid will be directed away from the adjuster mechanism.

2. Pressure Reducing High and Low Adjustable Settings by Electrical Selection (see Figure 5)

In this configuration a detent directional valve controls two pressure reducing valve heads and provides two different reduced pressure settings. As in the previous example, the highest pressure setting is controlled by the head located within the cartridge valve interface cover and the low pressure setting is controlled by the module sandwiched between the directional valve and the cover interface. At least 10.3 bar (150 PSI) spread is required between the high and low pressure settings to prevent interaction.

One of the features of a detent valve system is that only a pulse of current is required to position the directional valve and then it can be removed. This saves energy.

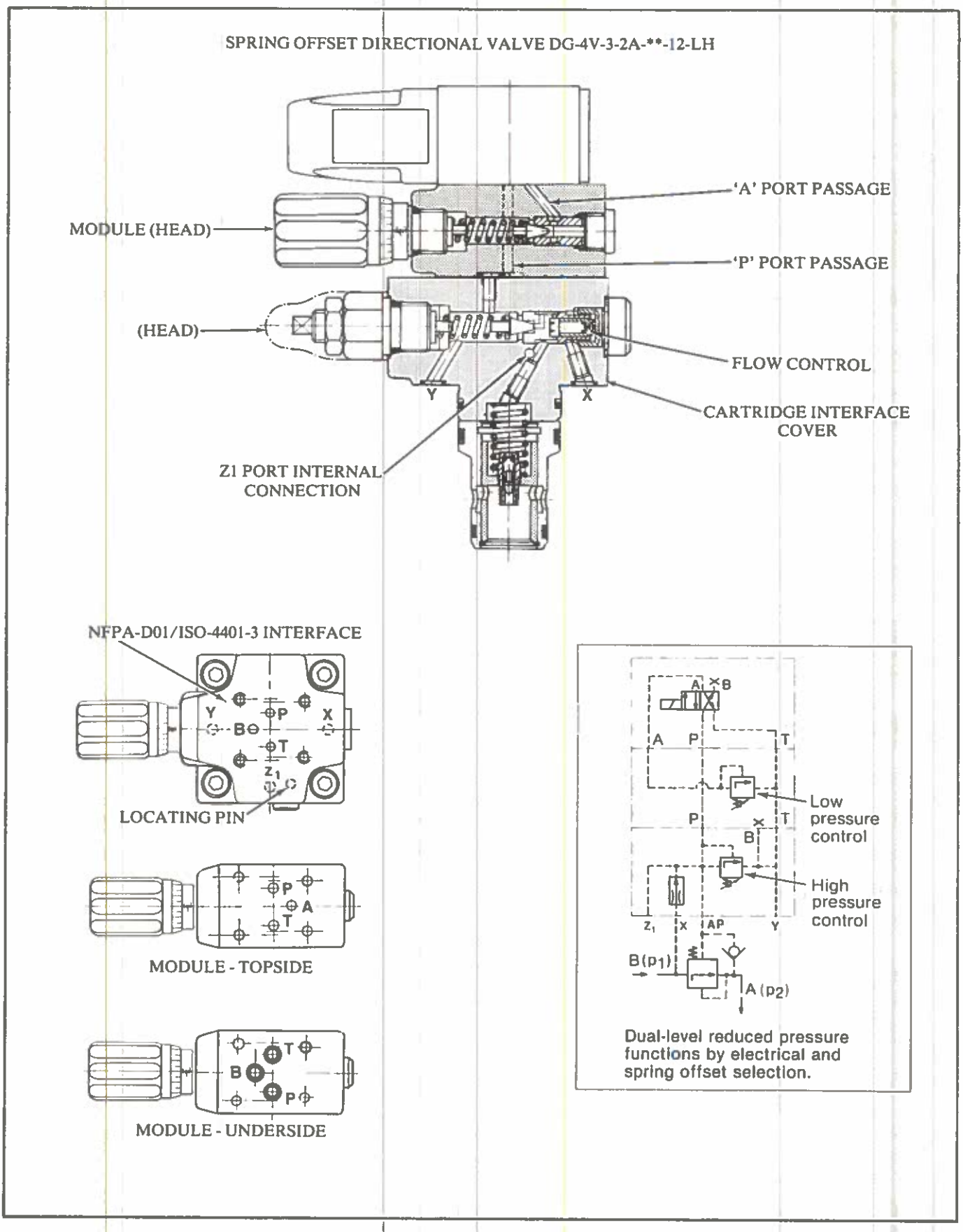


Figure 4. Pressure Reducing High and Low Adjustable Settings by Electrical and Spring Offset Selection

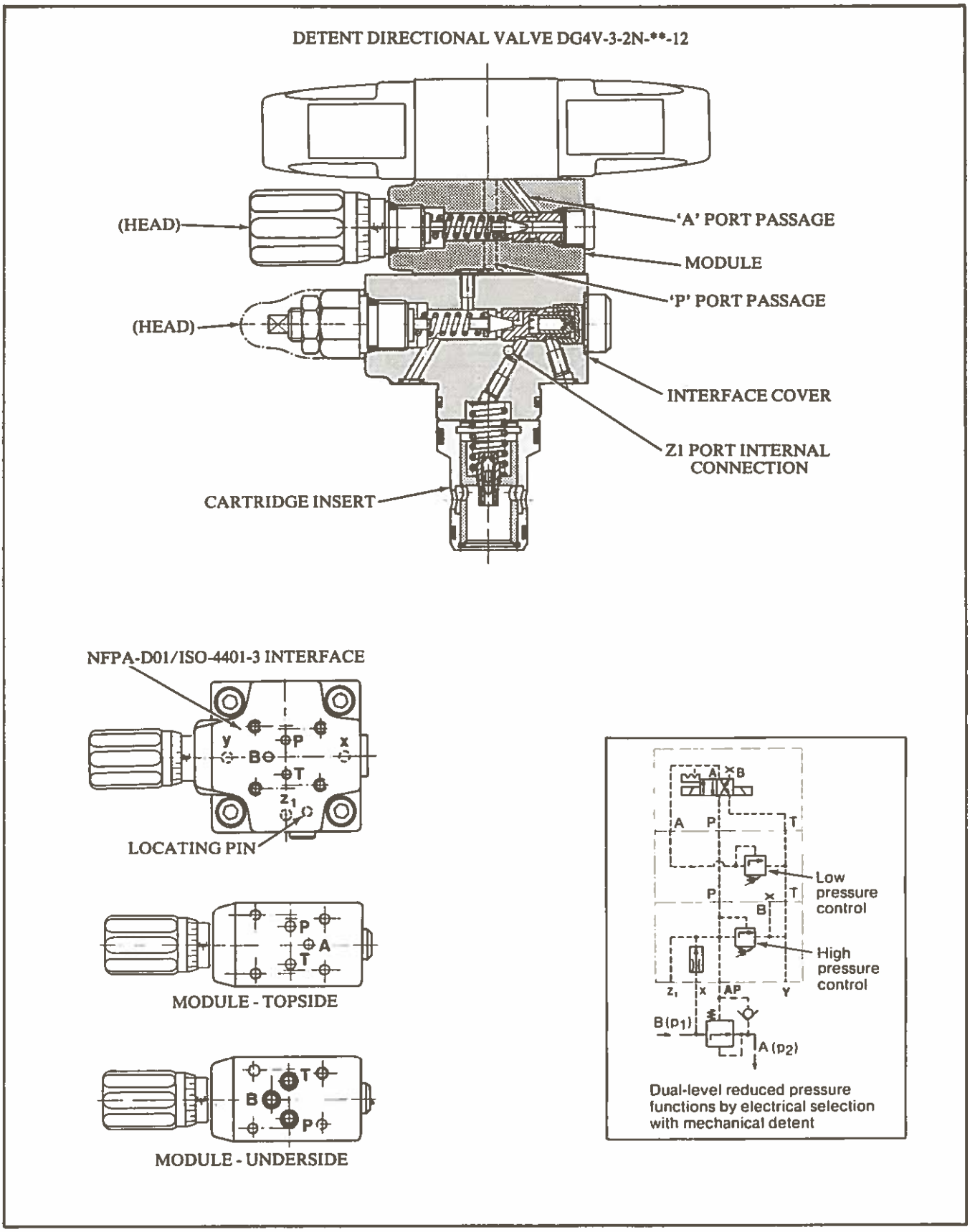


Figure 5. Pressure Reducing Valve High and Low Adjustable Settings by Electrical Selection with Mechanical Detents

3. Electrically Modulated Pressure Reducing Valve Function (see Figure 6)

The cartridge valve NFPA-D01/ISO-4401-3 interface cover accommodates the CGE-02-*-22 electrically modulated relief valve. This valve can be remotely controlled by a microcomputer or a regulated power supply with appropriate voltage/current control. Normally as current increases, pressure drop across the CGE valve increases. This will cause the pressure reducing valve pressure to follow the CGE valve. The high pressure excursion of the CGE valve is limited by the setting of the manual adjuster located in the cartridge valve interface section.

The CGE-02-*-22 electrically modulated relief valve is designed for 207 bar (3000 PSI) operation in the standard valve configuration. Special valves are available to extend this range through 345 bar (5000 PSI).

The 'Z' pilot part is for remote hydraulic control. Block the 'Z' port if the remote hydraulic control feature is not used.

A solid (M6 metric) plug (part number 471131) or SAE hex key plug (310169) *must* be installed into the 'B' port opening of the interface cover.

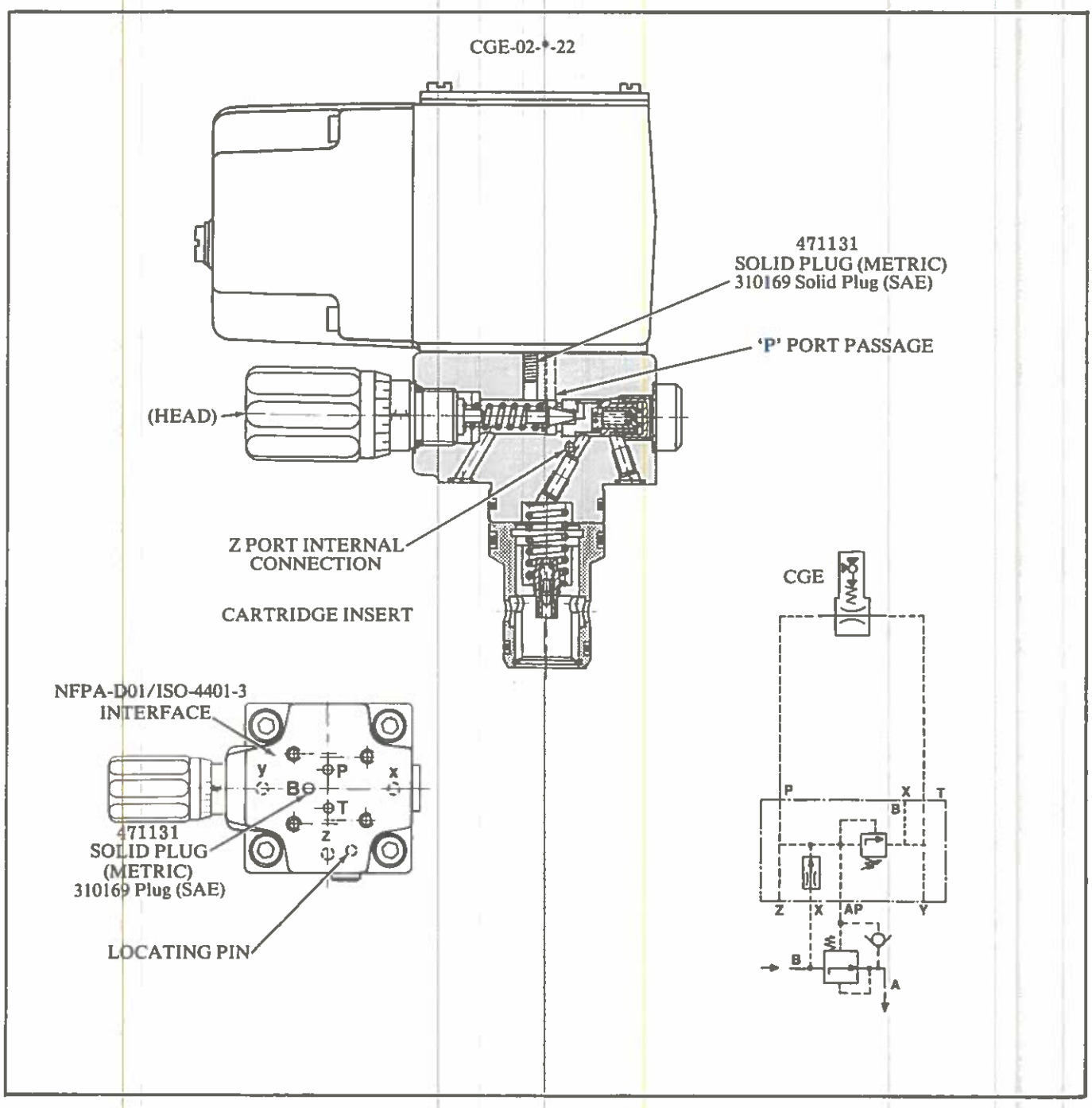


Figure 6. Electrically Modulated Pressure Reducing Function

Section IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS - The installation drawings listed in Table 1 show installation dimensions and port locations.

B. MOUNTING - Cartridge pressure reducing valves are designed to be installed into manifolds with most circuit connections within the manifold. This minimizes external circuit connections and provides a very compact package. Each cartridge valve installation is unique for a specific application. Many other valve functions can be included within the same manifold.

C. PIPING AND TUBING - If a cartridge pressure reducing valve is part of a manifold system that is actuator mounted, only pressure and tank lines will be required to the manifold. All pipes and tubing must be thoroughly cleaned along with all passages within the manifold. Recommended methods of cleaning are sandblasting, wire brushing, pickling and power flushing.

NOTE
For instruction on pickling, refer to instruction sheet 1221-S.

1. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

2. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

D. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components.

Any oil selected for use with pressure reducing valves must also be acceptable for the system pumping source and actuator.

Data sheet I-286-S for oil selection is available from Sperry Vickers Technical Publications, Troy, Michigan.

Oil recommendations noted in the data sheet is based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Sperry Vickers representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminants into the system.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination by sealing the system and/or by proper filtration of the air.

5. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc. cannot be overemphasized.

6. Thorough precaution should be taken, by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

E. OVERLOAD PROTECTION

A relief valve is required to limit pressure in the system to a prescribed maximum and protect components from excessive pressure. The setting of the relief valve depends on the design and work requirements of the system.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Sperry Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutions may result in early failure.

G. PRODUCT LIFE

The longevity of these products is dependent upon environment, duty cycle, operating parameters and system cleanliness. Since these parameters vary from application to application, the ultimate user must determine and establish the periodic maintenance required to maximize life and detect potential component failure.

H. TROUBLESHOOTING

By applying the basic operating principles discussed up to this point, a technician can in a relatively short time become proficient in the troubleshooting of cartridge pressure reducing valves. Basically, a pressure reducing valve can be considered as a variable flow control that senses outlet pressure and holds it constant by controlling flow to the load.

Section V - SERVICE AND MAINTENANCE

A. SERVICE TOOLS

STANDARD TOOLS

1. Torque wrench with hex bit adapter sockets. (Refer to unit being repaired and use the appropriate torque wrench.)

Size/mm	Torque (maximum)	
	N.m	lb. ft.
16	35	25.9
25	110	81.4

Table 8. Maximum Torque Wrench Size Required

2. Set of U.S. and metric hex key wrenches
3. Set of small pin punches
4. 3/8 inch ratchet with sockets
5. Small ball peen hammer
6. Metric ruler
7. 3/8 in. length of brass rod (approx. 15 cm, 6 in., long)

SPECIAL TOOLS - No special tools required.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants.

If the fluid becomes contaminated, the system should be drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin system components. If bubbles are seen, locate the source of the air and seal the leak.

5. A unit which is running excessively hot or noisy is a potential failure. Should a unit become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the hydraulic unit. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

Manual adjustments are provided to set system pressure.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of external adjusters is required on a periodic basis.

Section VI - OVERHAUL

CAUTION

Before breaking a circuit connection, make sure that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

CAUTION

Absolute cleanliness is essential when working with a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Discard and replace all 'O' rings and back-up rings removed during disassembly.

A. COVER REMOVAL

Loosen and remove the four cover bolts, item (1), shown in Figure 7. Pull cover from the manifold. Do not remove cartridge insert at this time.

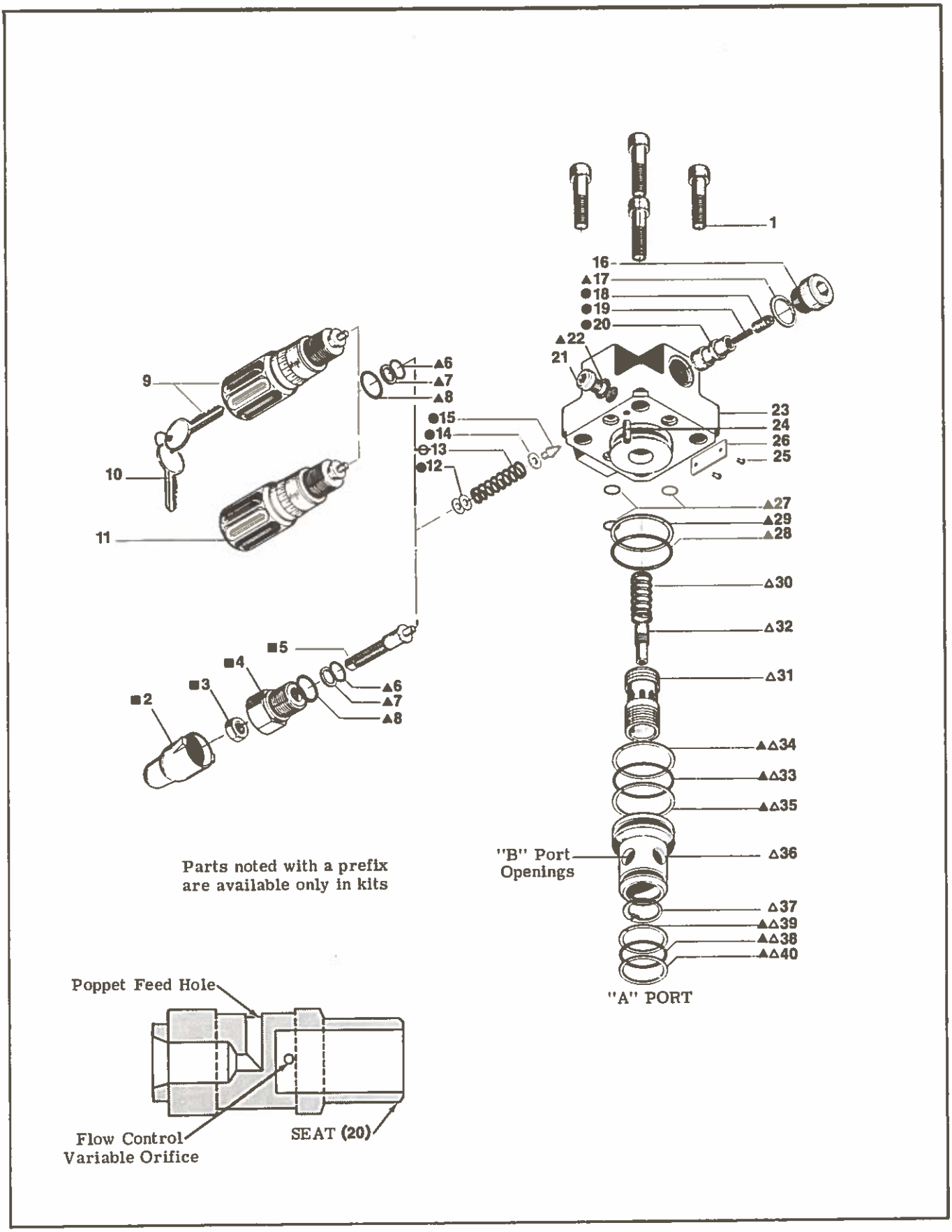


Figure 7. Exploded View of a Pressure Reducing Valve

INDEX NO	PART NO 16 mm	PART NO 25 mm	DESCRIPTION	QTY
1	See Table 9		Bolt Kit (Cover)	1
	See Figure 11		Bolt Kit (Directional Valve)	1
■2	762607	762607	Cap	1
■3	764177	764177	Locknut	1
■4	579692	579692	Adapter	1
	(Torque to 100 N. m (73.7 lb.ft.)			
■5	764176	764176	Adjusting Screw	1
▲6	262350	262350	"O" Ring	1
▲7	197588	197588	Back-Up Ring	1
▲8	262355	262355	"O" Ring	1
9	637463	637463	Micrometer Knob & Key Lock S/A	1
10	814573	814573	Keys	1 set (2)
11	637642	637642	Micrometer Knob	1
●12	762920	762920	Shims	A/R
⊖13	762928	762928	Spring (5 - 125 bar)	1
	762929	762929	Spring (5 - 245 bar)	1
	762930	762930	Spring (5 - 350 bar)	1
●14	762921	762921	Washer	1
●15	290057	290057	Poppet	1
16	579921	579921	Plug (0.75 - 16 UNF-2A Thread)	1
	(Torque to 54-59 N. m, 40-44 lb. ft.)			
▲17	263497	263497	"O" Ring	1
●18	764172	764172	Spool	1
●19	544103	544103	Spring	1
●20	764171	764171	Seat	1
21	591768	591768	Plug (0.312 - 24 UNF-2A Thread)	1
	(Torque to 10 N.m(7.4 lb.ft.)			
▲22	263492	263492	"O" Ring	1
23	See Table 10		Cover (Standard)	1
	See Table 12		Cover (Interface)	1
24	161236	226797	Rest Pin	1
25	AX-36212	AX-36212	Screw	2
26	199082	199082	Nameplate	1
▲27	200082	200083	"O" Ring	3
▲28	179347	154026	"O" Ring	1
▲29	271732	271787	Back Up Ring	1
△30	764166	764309	Spring	1
△31	764164	764307	Spool	1
△32	764134	764134	Poppet Valve S/A	1
▲△33	179347	154026	"O" Ring	1
▲△34	271732	271787	Back Up Ring	1
▲△35	271732	271787	Back Up Ring	1
△36	580366	580432	Sleeve	1
△37	92757	103989	Retaining Ring	1
▲△38	199812	199813	"O" Ring	1
▲△39	271728	271733	Back Up Ring	1
▲△40	271728	271733	Back Up Ring	1
	▲920172	920174	Seal Kit Includes Parts Prefixed with a▲	1
	920173	920175	F3 Equivalent Seal Kit	1
	△(Cartridge Valve Insert Kit - See Table 11)			1
	■926227	926227	Locknut Adjuster Kit	1
	●926228	926228	Washer, Poppet, Seat, Spool & Spring (Pilot S/A Kit)	1

Figure 7. Pressure Reducing Valve Parts

B. SUBASSEMBLIES AVAILABLE FOR CARTRIDGE PRESSURE REDUCING VALVES WITH STANDARD COVERS (See Figure 8)

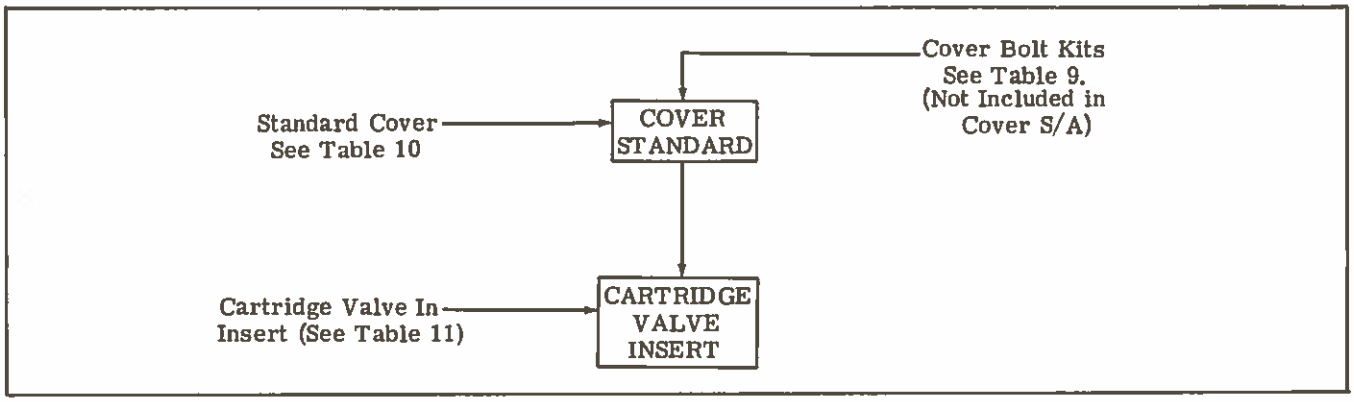


Figure 8. Block Diagram of the Valve with Standard Cover

TYPE	16 mm	25 mm
Inch	590702	590704
mm	590703	590705
Torque	35 N. m (26 lb. ft.)	110 N. m (81 lb. ft.)

Table 9. Cover Bolt Kits (Not included in cover S/A)

COVER SIZE	PRESSURE RANGE	LOCKNUT	MICROMETER KNOB	MICRO. KNOB & KEYLOCK	COVER NO. (Reference)
16 mm	5 - 125 bar	580336	580342	580345	◆579982
	5 - 245 bar	580337	580343	580346	
	5 - 350 bar	580338	580344	580347	
25 mm	5 - 125 bar	580379	580385	580388	◆580266
	5 - 245 bar	580380	580386	580389	
	5 - 350 bar	580381	580387	580390	

◆Not available as spare parts

Table 10. Standard Cover S/A

16 mm	25 mm
580360	580421

Table 11. Cartridge Pressure Reducing Valve Insert Kits

C. REMOVAL OF ADJUSTER MECHANISMS FROM COVER (Refer to Figure 7)

1. Locknut Adjuster - Remove locknut adjuster parts (2 through 8) in numerical sequence.

2. Micrometer Knob - Refer to Figure 9.

a. Push rollpin (1) into bolt (4).

b. Pull adjuster knob (2) and scale ring (3) from assembly to expose adjustment rod (9) and bolt (4).

c. Push rollpin (6) through adjustment rod (9) and thread adjustment rod and bolt counterclockwise from adapter (16). Press rollpin (1) through bolt. Retain rollpins (1 & 6) for assembly.

d. Push two rollpins (10) into adapter (16) just enough to remove retaining ring (11). Remove retaining ring, ratchet plate (12), ball (13), spring (14) and scale (15).

e. Thread adapter (16) from cover and remove 'O' rings (17 & 18). Discard the 'O' rings.

f. Press two rollpins (10) through adapter (16) into the center threaded area and remove. Retain the rollpins for assembly.

g. Slide adjusting pin (19) from adapter (16).

h. Remove 'O' ring (20) and back-up ring (21) from within adapter (16) and discard.

3. Micrometer Knob with Keylock (Refer to Figure 9)

a. Unlock adjuster knob (2) with key (5) and rotate knob to engage detent (less than one turn).

b. Push rollpin (7) into adjustment rod (9).

c. Lock adjuster knob (2) and remove key (5). Pull adjuster knob and keylock (5) from assembly to expose adjustment rod (9).

d. Push rollpins (6 & 7) through adjustment rod (9), then thread adjustment rod (9) counterclockwise from adapter (16).

e. Push two rollpins (10) into adapter (16) just enough to remove retaining ring (11). Remove retaining ring, ratchet plate (12), ball (13), spring (14) and scale (15).

f. Thread adapter (16) from cover and remove 'O' rings (17 & 18). Discard the 'O' rings.

g. Press two rollpins (10) through adapter (16) into the center threaded area and remove. Retain the rollpins for assembly.

h. Slide adjusting pin (19) from adapter (16).

i. Remove 'O' ring (20) and back-up ring (21) from within adapter (16) and discard.

D. REMOVAL OF STANDARD AND INTERFACE COVER PARTS (Refer to Figure 7)

1. Remove parts (12 through 19) in numerical sequence.

2. DO NOT remove seat (20) unless inspection of poppet (15) or piston (18) reveals a problem.

3. Remove plug and 'O' ring (21 & 22).

4. DO NOT remove rest pin (24) from cover (23) unless it is damaged.

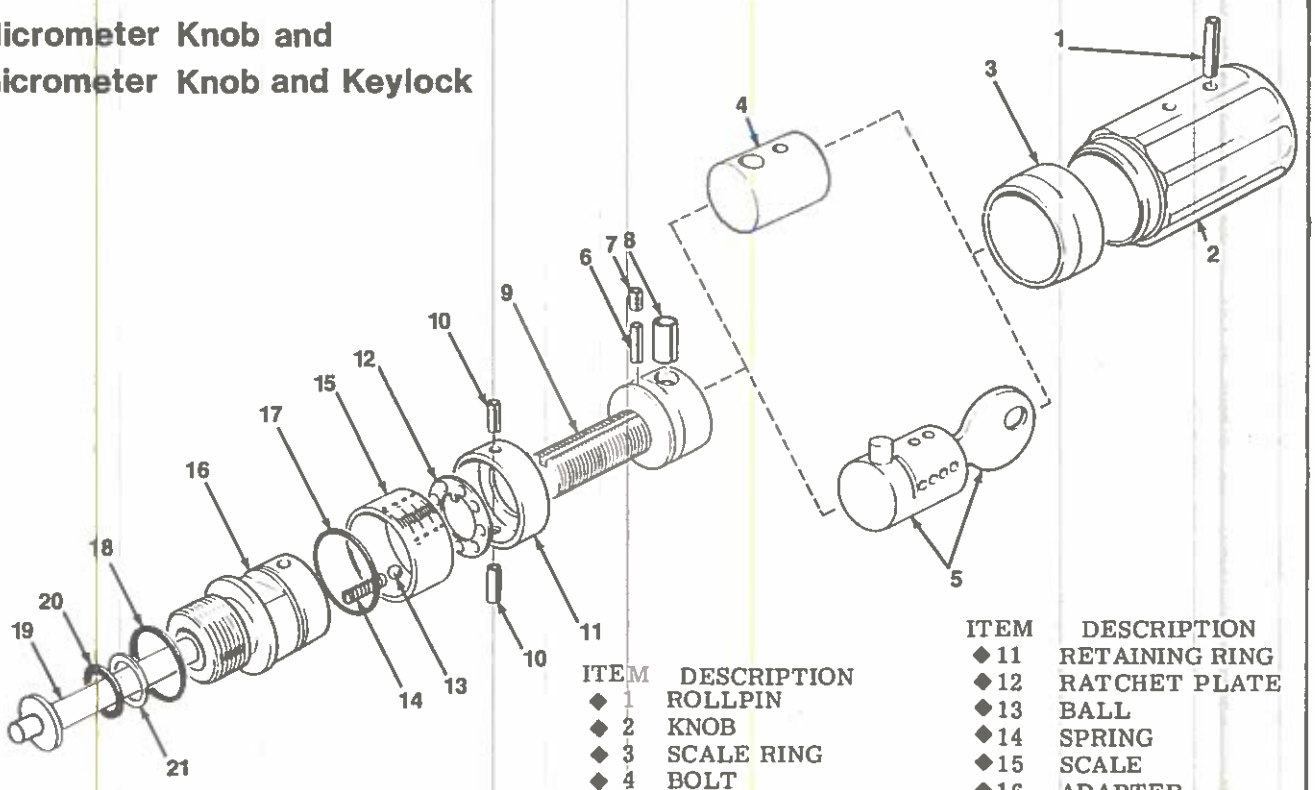
5. DO NOT remove nameplate (26) or screws (25) from cover. These parts are not available as service items.

6. Remove seals (27 through 29) and discard.

NOTE
The following step (7) pertains to interface cover units only.

7. Remove directional control and low pressure module or electrically modulated pressure control attaching screws. Separate the valve parts from the cover. Discard 'O' rings.

Micrometer Knob and
Micrometer Knob and Keylock



ITEM	DESCRIPTION
◆ 1	ROLLPIN
◆ 2	KNOB
◆ 3	SCALE RING
◆ 4	BOLT
◆ 5	KEYLOCK
◆ 6	ROLLPIN
◆ 7	ROLLPIN
◆ 8	ROLLPIN
◆ 9	ADJUSTING ROD
◆10	ROLLPIN

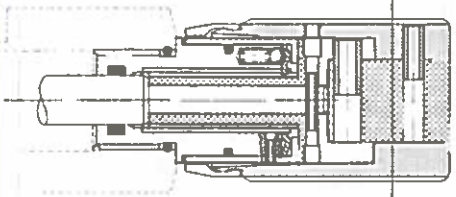
ITEM	DESCRIPTION
◆11	RETAINING RING
◆12	RATCHET PLATE
◆13	BALL
◆14	SPRING
◆15	SCALE
◆16	ADAPTER
▲17	"O" RING
▲18	"O" RING
◆19	ADJUSTING PIN
▲20	"O" RING
▲21	BACK UP RING

Figure 9. Exploded View

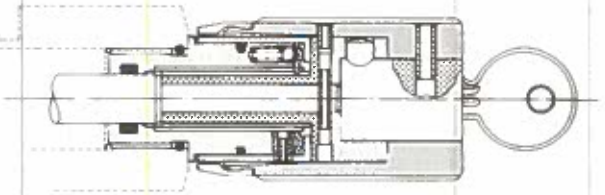
◆ INDIVIDUAL ITEMS ARE NOT AVAILABLE AS SPARE PARTS. REFER TO FIGURE 7, PARTS TABULATION FOR ADJUSTER S/A.

▲ INCLUDED IN SEAL KITS

MICROMETER KNOB AND KEYLOCK SEAL KIT NUMBER 920233



Adjuster Micrometer Knob



Adjuster Micrometer Knob and Keylock

E. DISASSEMBLY OF LOW PRESSURE MODULE (See Figure 10)

1. Disassemble the manual adjuster parts (2 through 9) in numerical sequence.

2. Remove parts (13 through 18) in numerical sequence.

3. DO NOT remove seat (19) unless inspection of poppet (16) reveals a problem.

4. DO NOT remove nameplate (21) or screws (22). These parts are not available as service items.

5. DO NOT remove rest pin (23) unless it is damaged.

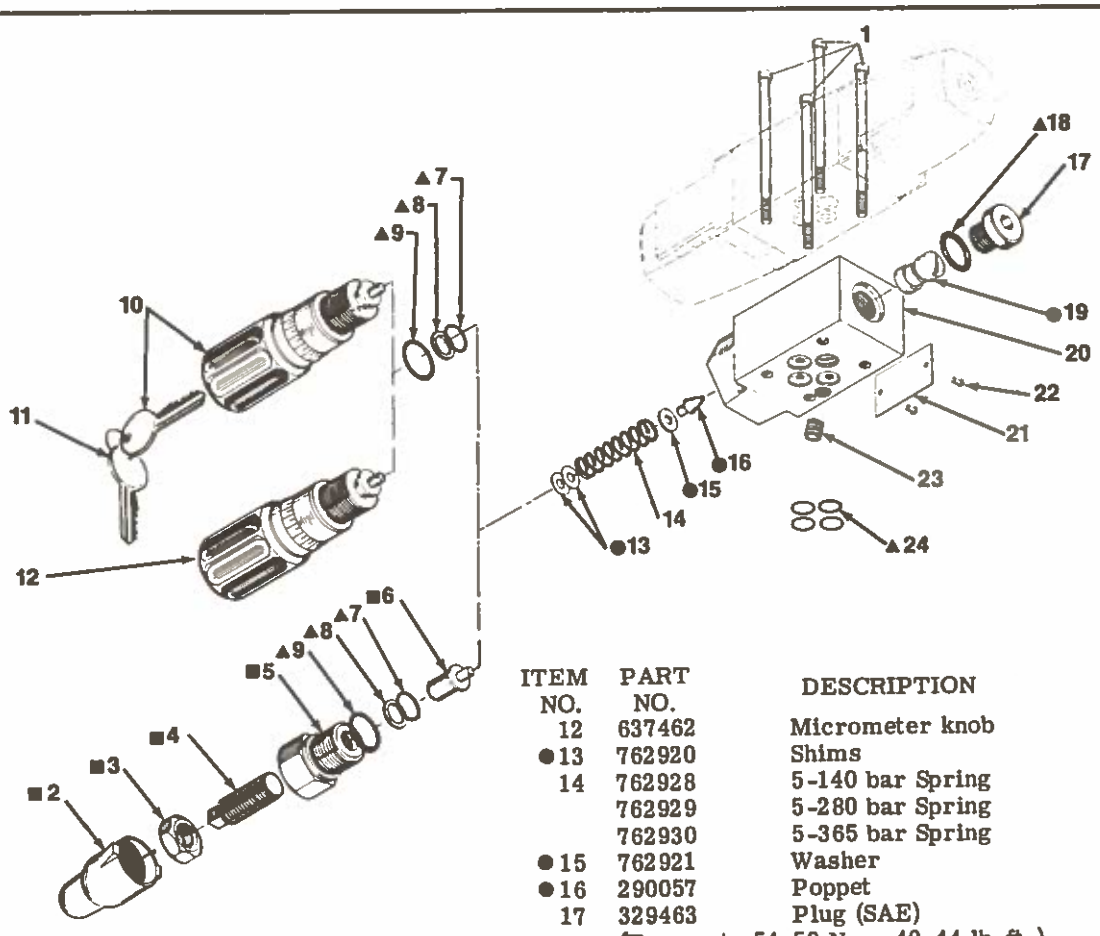
6. Remove and discard face seals (24).

F. REMOVAL OF CARTRIDGE INSERT FROM THE MANIFOLD (See Figure 7)

1. Remove spring (30) and spools S/A (31) from sleeve (36).

2. Insert two hooked tools (hex key wrenches) into the 'B' pressure port openings of sleeve (36). Pull sleeve from the manifold. Be careful not to scratch the inside surface finish of the sleeve during removal.

3. Remove and discard sealing parts (33 through 35) and (38 through 40) in item number sequence.



ITEM NO.	PART NO.	DESCRIPTION	QTY
1	See Figure 11	Bolt Kit (Module)	1
■ 2	762607	Cap	1
■ 3	761190	Lock Nut	1
■ 4	762918	Adjusting Screw	1
■ 5	579922	Adapter	1
	(Torque to 100 N. m,73. 7 lb. ft.)		
■ 6	762919	Bolt Adjustment	1
▲ 7	262350	"O" Ring	1
▲ 8	197588	Back Up Ring	1
▲ 9	262355	"O" Ring	1
10	637463	Micrometer knob S/A	1
11	814573	Keys	1 set(2)

ITEM NO.	PART NO.	DESCRIPTION	QTY
12	637462	Micrometer knob	1
●13	762920	Shims	A/R
14	762928	5-140 bar Spring	1
	762929	5-280 bar Spring	1
	762930	5-365 bar Spring	1
●15	762921	Washer	1
●16	290057	Poppet	1
17	329463	Plug (SAE)	1
	(Torque to 54-59 N. m, 40-44 lb. ft.)		
▲18	263497	"O" Ring	1
●19	762922	Seat	1
20	580036	Body	1
21	199082	Nameplate	1
22	AX-36212	Screw	2
23	472553	Rest Pin	1
▲24	154006	"O" Ring	4
	▲920257	Seal Kit Includes parts noted with a ▲	1
	920258	F3 Equivalent seal kit	1
	■941472	Locknut adjuster kit	1
	●941473	Poppet & seat kit	1

Figure 10. Exploded View of Low Pressure Module Assembly

G. SUBASSEMBLIES AVAILABLE FOR CARTRIDGE VALVES WITH INTERFACE COVERS (See Figure 11)

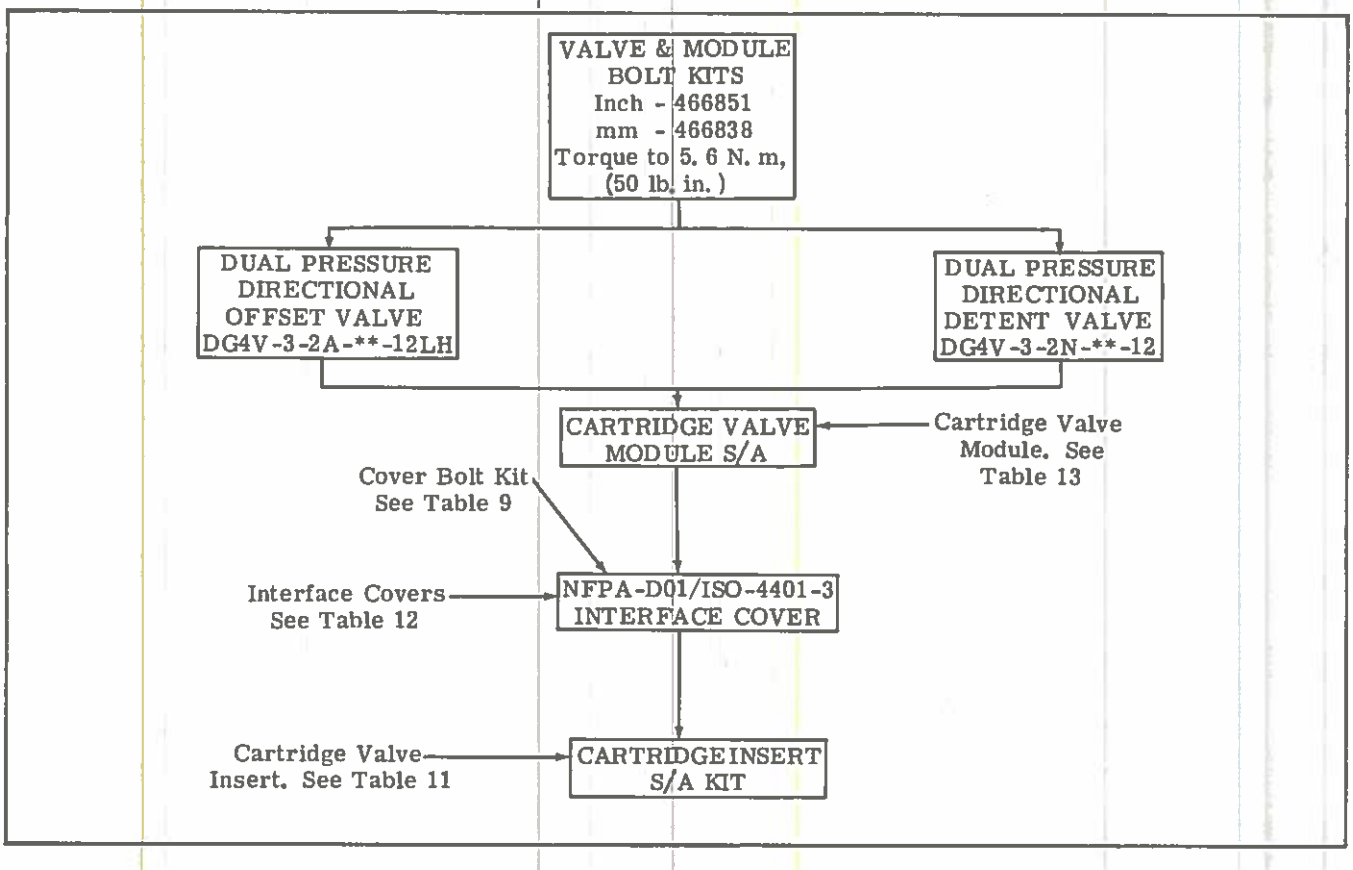

VALVE & MODULE BOLT KITS
Inch - 466851
mm - 466838
Torque to 5. 6 N. m, (50 lb. in.)
DUAL PRESSURE DIRECTIONAL OFFSET VALVE DG4V-3-2A-**-12LH
DUAL PRESSURE DIRECTIONAL DETENT VALVE DG4V-3-2N-**-12
CARTRIDGE VALVE MODULE S/A
Cartridge Valve Module. See Table 13
Cover Bolt Kit See Table 9
Interface Covers See Table 12
NFPA-D01/ISO-4401-3 INTERFACE COVER
Cartridge Valve Insert. See Table 11
CARTRIDGE INSERT S/A KIT

Figure 11. Block Diagram of Cartridge Pressure Reducing Valve

COVER SIZE	PRESSURE RANGE	LOCKNUT	MICROMETER KNOB	MICRO. KNOB & KEYLOCK	COVER (Reference Only)
25 mm	5-125 bar	580391	580394	580397	◆580265
	5-245 bar	580392	580395	580398	
	5-350 bar	580393	580396	580399	

◆Not available for spares.

Table 12. NFPA-D01/ISO-4401-3 Interface Cover Subassemblies

COVER SIZE	PRESSURE RANGE	LOCKNUT	MICROMETER KNOB	MICRO. KNOB & KEYLOCK	SPRING (Reference Only)
25 mm	5-125 bar	580031	580076	580261	580268
	5-245 bar	580032	580077	580323	580269
	5-350 bar	580033	580092	580324	580270

Table 13. Cartridge Valve Module S/A

H. INSPECTION REPAIR AND REPLACEMENT

NOTE

Replace all parts that do not meet the following specifications.

CAUTION

DO NOT intermix parts from different valves or parts of a single valve. Poppets, springs and shims along with the cartridge spools are mated parts. Poppets and spools develop a wear pattern and may leak if interchanged to a different position in the valve.

NOTE

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. clean compressed air is particularly useful in cleaning the cover orifices and manifold passages.

1. Inspect all components for wear, erosion and/or seizure. Inspect manifold for burrs and sharp edges that may cause a sealing problem.

2. Inspect adjuster mechanism parts for wear. Replace the complete mechanism if parts are found unfit for service.

3. Inspect springs (13 & 30, Figure 7) and (14, Figure 10) to be square and straight. Replace springs that show evidence of wear.

4. Inspect the cartridge insert spool (31) for wear and erosion of the port area. If wear is evident or the check valve is inoperative, replace the complete cartridge insert kit.

5. If a pilot poppet (15) requires replacement, replace the poppet (15), seat (20), valve (18) and spring (19) as a set. Refer to Figure 7. To replace the seat, use a brass rod and press or drive the seat from the cover. If the seat is to be replaced, the new poppet must be mated to the seat to prevent leakage prior to installation within the cover. The following is an explanation of the mating operation.

a. Position the poppet within its seat and hold the poppet centered.

b . Tap the end of the poppet a couple of times with a small hammer.

c . Remove the poppet and observe a contact impression around its perimeter. If the contact impression is broken, repeat the mating operation.

d . Press the poppet in place within the cover. Make sure the poppet feed hole located in the seat is directed away from cartridge insert (31). See insert view Figure 7.

e . Clean up the cover bore to remove any debris that may have developed during the installation of the seat.

I. ASSEMBLY OF THE CARTRIDGE VALVE (Refer to Figure 7)

NOTE

Obtain a complete seal kit for the unit being repaired. Refer to Figure 7 parts tabulation for the seal kit information.

NOTE

Assembly is accomplished in the reverse item number sequence. Special procedures are noted in the following text.

1. Install sealing parts (40 through 38) and (35 through 33) on sleeve (36). Lubricate with system fluid to facilitate assembly.

2. If retaining ring (37) was removed from within sleeve (36), install retaining ring with sharp break edge toward the 'A' port.

3. Install sleeve (36) within the manifold. Some difficulty may be encountered due to the 'O' rings and back-up rings. A hardwood block and large 'C' clamp may be useful during installation of the sleeve.

4. Install spool S/A (31) and spring (30) into the sleeve. Refer to Figure 7 for spool orientation. Cover with kraft paper to prevent contaminants from entering valve.

5. If rest pin (24) was removed, install a new rest pin in place within the cover.

6. Assemble back-up ring (29) and 'O' ring (28) within the 'O' ring groove of the cover.

7. Install 'O' ring (22) on plug (21) and thread in place. Torque plug to 10 N.m. (7.4 lb. ft.).

8. Install spring (19) and valve (18) into cavity of seat (20). Inspect valve to make sure it does not bind or hang up in the seat. Place a new 'O' ring on plug (16) and thread in place over the valve. Torque plug to 39 N.m (28.7 lb. ft.).

9. Insert poppet (15) into washer (14). Lubricate the end of the poppet with petroleum jelly and insert into spring (13). The petroleum jelly will hold poppet and spring together during assembly. Insert spring and poppet into the cover bore. Make sure poppet is in place within its seat.

NOTE

This completes assembly of the cover with the exception of the manual adjuster mechanism. Proceed to the appropriate manual adjuster mechanism used on your unit and assemble as shown.

10. Locknut Adjuster - Lubricate and assemble locknut adjuster parts in the reverse item number sequence. Install parts (8 through 3). See Figure 7. Make sure shim (12) is located over adjusting screw (5) before assembly into cover. Adjusting screw end must engage the center of spring (13) at assembly. Torque adapter (4) to 100 N.m (73 lb. ft.). Cover (2) will be installed after pressure is adjusted.

11. Micrometer Knob - Refer to Figure 9 during assembly.

a. Install back-up ring (21) and 'O' ring (20) within adapter (16). Lubricate seals with system fluid.

b. Insert adjusting pin (19) into adapter (16).

c. Install 'O' rings (18 & 17) on adapter (16). Install shims (12, Figure 7) over end of adjusting pin and thread in place within the cover. Torque to 100 N.m (73 lb. ft.).

NOTE

If shims (12), spring (13), poppet (15) or seat (20), Figure 7, were replaced, the pressure range of the valve will require calibration. DO NOT complete assembly of the knob until calibration is completed. If the original parts are being returned to service, calibration will not be required. Proceed to the following step 11.d.

If calibration is required, thread adjustment rod (9, Figure 9) into adapter (16) until the rollpin hole located in the adjusting rod and adjusting pin are aligned. Install rollpin (6) and proceed to Section VII, Pressure Calibration.

d. Install scale (15) in place over 'O' ring (17). Make sure scale is oriented correctly.

e. Lubricate spring (14), ball (13) and ratchet plate (12) with petroleum jelly and install in place. Place retaining ring (11) over the ratchet plate and align rollpin holes. Insert rollpins (10) flush with outside surface of retaining ring. DO NOT press rollpins (10) past flush or the adjuster will bind.

f. Lubricate and thread adjustment rod (9) into adapter (16). Make sure tang of ratchet plate is in alignment with groove of adjustment rod. Thread adjustment rod in until rollpin hole of adjusting pin is in alignment with hole in adjustment rod. Install rollpin (6) into hole and center as shown in Figure 8 sectional view. Move the adjustment rod, the adjusting pin should rotate. This verifies correct alignment.

g. Install knob (2) and scale ring (3) as an assembly over bolt (4). Hold adjusting pin (19) and align rollpin hole (1) with opening in bolt (4). Install rollpin (1) flush with outside of knob (2). Proceed to step 13.

12. Micrometer Knob with Keylock - Refer to Figure 9 during assembly.

a. Install back-up ring (21) and 'O' ring (20) within adapter (16). Lubricate seals with system fluid.

b. Insert adjusting pin (19) into adapter (16).

c. Install 'O' ring (18 & 17) on adapter (16) and thread in place within the cover. Torque to 100 N.m (73 lb. ft.).

NOTE

If shim (12), spring (13), poppet (15) or seat (20) Figure 7 were replaced, the pressure range of the valve will require calibration. DO NOT complete assembly of the knob until calibration is completed. If the original parts are being returned to service, calibration will not be required. Proceed to the following step, 12.d.
If calibration is required, thread adjustment rod (9) into adapter (16) until the rollpin hole located in the adjusting rod and adjusting pin are aligned. Install rollpin (6) and proceed to Section VII, Pressure Calibration.

d. Install scale (15) in place over 'O' ring (17). Make sure scale is oriented correctly.

e. Lubricate spring (14), ball (13) and ratchet plate (12) with petroleum jelly and install in place. Place retaining ring (11) over the ratchet plate and align rollpin holes. Insert rollpins (10) flush with outside surface of retaining ring. DO NOT press rollpins (10) past flush or the adjuster will bind.

f. Lubricate and thread adjustment rod (9) into adapter (16). Make sure tang of ratchet plate is in alignment with groove of adjustment rod. Thread adjustment rod in until rollpin hole of adjusting pin is in alignment with hole in adjustment rod. Install rollpin (6) into hole and center as shown in Figure 8 sectional view. Move the adjustment rod, the adjusting pin should rotate. This verifies correct alignment.

g. Lock the keylock located within knob (2). Install knob (2) with keylock (5) and scale ring (3) over adjusting rod (9). Turn key to unlock and rotate knob until detent locks in place within the adjusting rod (less than a full turn). Install rollpin (7) in place flush with outside of knob (2). DO NOT press past flush or knob may bind. Lock knob, the knob should rotate freely in the locked condition.

13. Lubricate and insert 'O' rings (27) into cover, then, install the cover S/A on the manifold. Use bolt kits called out in Table 9.

Section VII - PRESSURE CALIBRATION

A. CALIBRATION ON A TEST STAND

NOTE

Modify an existing test stand or build up the stand shown in Figure 12. Prepare test blocks for the 16mm and 25mm valves. Refer to Figure 13 for cartridge insert hole dimensions. Make sure the blocks have sufficient mass to handle the applied pressure. Install a cartridge insert into the test block. See Table 11.

1. Install cover subassembly on the test block and torque cover screws to the values shown in Table 9.

CAUTION

In the following step (2) if test stand capabilities are less than the maximum test pressure setting, adjust the system relief valve to an appropriate pressure just below test stand maximum.

2. Close globe valve (1) and set system relief valve. Valve test pressure can be read on gauge #1.

3. Open globe valve (1) and close globe valve (2). Adjust cartridge pressure reducing valve cover under test to its maximum pressure setting as noted on pressure gauge (2). Refer to Table 10 for cover pressure ranges (1 bar = 14.5 PSIG). If the

maximum setting is above the test stand's capability, adjust the cartridge pressure reducing valve to a pressure just below the test stand's limit and perform steps 4 through 7. If the capability of the stand is not exceeded, omit steps 4 and 5 and perform steps 6 and 7.

4. Lower the reduced pressure setting 1000 PSIG and count the number of turns on the valve adjuster mechanism. This gives a relationship between pressure change and turns. Record this information and return the valves setting to the original pressure setting (just below test stands limit).

5. Open globe valve (2) and rotate the valve's adjuster mechanism clockwise until it bottoms out and count the number of turns. Use information recorded in previous step to determine the maximum setting of the valve (i.e. If 10 turns = 1000 PSIG, then $\frac{1000}{10}$ = 100 PSIG/turn.

CAUTION

BE SURE to turn off the test stand and allow pressure to zero before adjustment of the shims is accomplished in the following step.

6. Measure or estimate the maximum pressure setting of the valve and adjust shims (12, Figure 7) accordingly. Adding shims increases pressure.

7. If the cartridge valve uses a micrometer knob or micrometer knob with keylock, return to the appropriate assembly procedure step (Section VI-I.11.d or VI-I.12.d). Remove rollpin (6) and adjusting rod (9). Complete assembly of the knob. Then perform step VI-I-13. The assembly of the cover to the manifold.

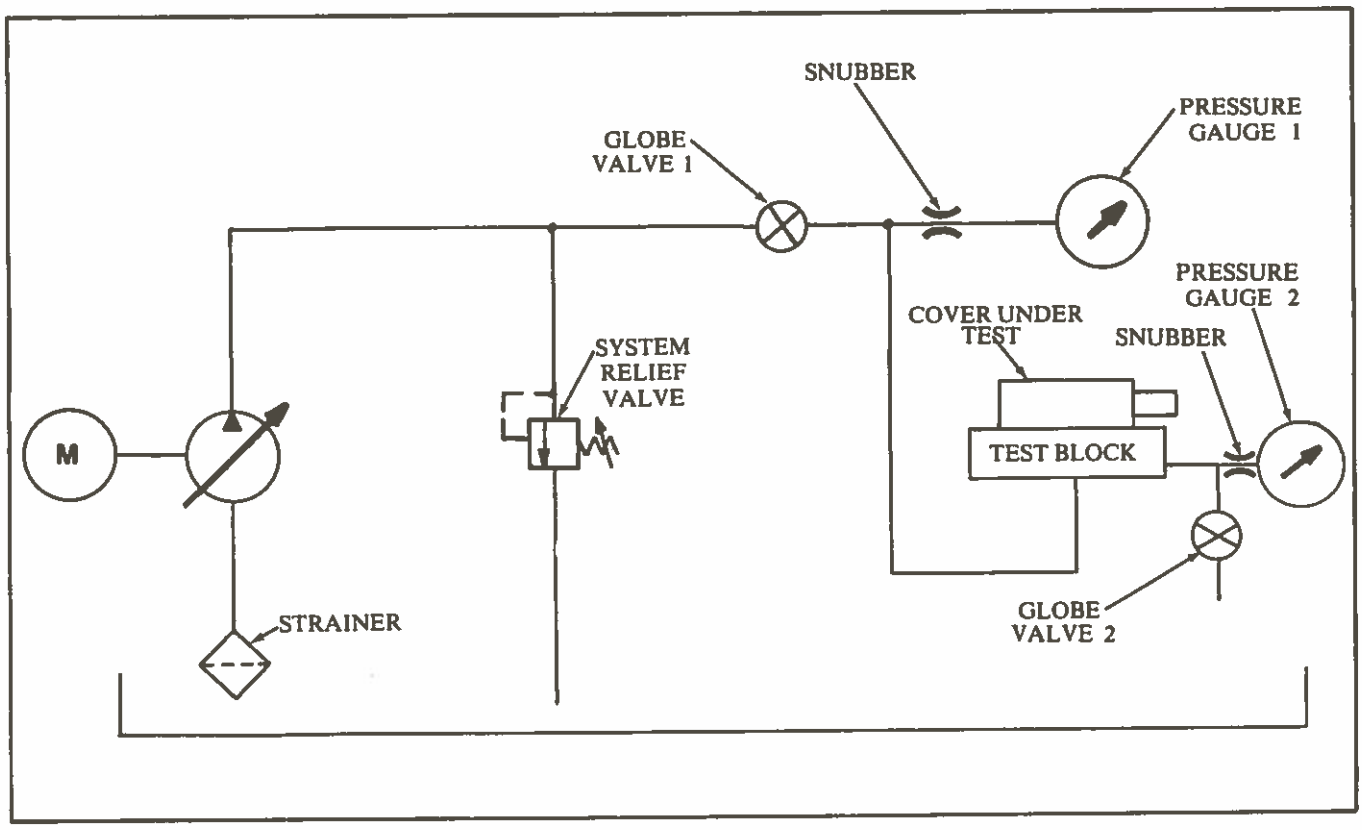
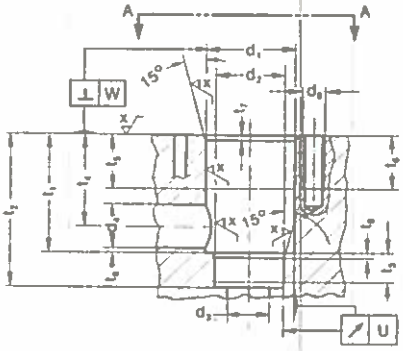
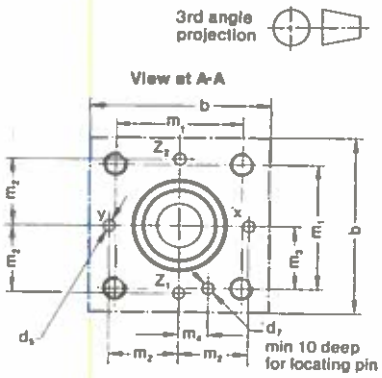


Figure 12. Test Stand

Recess dimensions to DIN 24342





Dimension	Nominal size – metric (inches)	
	16	25
b	65 (2.56)	85 (3.35)
d_1	32,000 (1.2598) 32,025 (1.2608)	45,000 (1.7717) 45,025 (1.7726)
d_2	25,000 (0.9843) 25,021 (0.9851)	34,000 (1.3386) 34,025 (1.3396)
d_3 max.	16 (.63)	25 (.98)
d_4	16 (.63)	25 (.98)
d_4 max.	25 (.98)	32 (1.26)
d_5 max.	4 (.157)	6 (.236)
d_6 Thread	M8 (.3125-18)	M12 (.500-13)
d_7	4,000 (.1575) 4,180 (.1646)	6,000 (.2362) 6,180 (.2433)
m_1 ±0.2 (± 008)	46 (1.811)	58 (2.284)
m_2 ±0.2 (± 008)	25 (.984)	33 (1.299)
m_3 ±0.2 (± 008)	23 (.906)	29 (1.142)
m_4 ±0.2 (± 008)	10,5 (.414)	16 (.630)
t_1 +0.1 (+ 004)	43 (1.692)	58 (2.283)
t_2 +0.1 (+ 004)	56 (2.204)	72 (2.834)
t_3 *	11 (.433)	12 (.472)
t_4	34 (1.338)	44 (1.732)
t_4 to d_4 max.	29.5 (1.161)	40.5 (1.594)
t_5 *	20 (.787)	30 (1.181)
t_6 Thread Depth	20 (.787)	25 (.984)
t_7	2 (.078)	2.5 (.098)
t_8	2 (.078)	2.5 (.098)
t_9	1.5 (.059)	1.5 (.059)
U	0,03 (.0012)	0,03 (.0012)
W	0,05 (.002)	0,05 (.002)
x_{Ra}	1,6 micrometre (63 microinches)	

* Depth of finish "x_{Ra}" in hole.

Figure 13. Test Block Cartridge Insert Hole Dimensions (metric)

B. CALIBRATION ON THE MACHINE

WARNING

Before breaking a circuit connection, be certain that power is off and the system pressure has been relieved. Lower all vertical cylinders and block any load that could generate pressure.

1. Remove plug (21) and install a suitable pressure gauge in the opening. The pressure at the vent cross port opening will be very close to the outlet pressure of the reducing valve.

2. Set the cartridge pressure reducing valve manual adjuster at minimum (fully counterclockwise) position.

3. Start-up the machine and read gauge pressure to be minimum.

4. Thread manual adjuster clockwise to the maximum recommended pressure for the system. Record the pressure.

5. Turn the manual adjuster counterclockwise until pressure reduces 1000 PSIG. Record the full number of revolutions of the manual adjuster. This will give an indication of the number of turns per 1000 PSIG (i.e. $\frac{1000}{10}$ = 100 PSIG/turn). This information can be used to estimate the maximum pressure range setting of the cartridge pressure reducing valve. Return the setting to the maximum recommended pressure of step 4.

6. Turn the machine off, observe pressure gauge, it must go to zero (0) before adjustment of shims (12, Figure 7) is undertaken in the following step.

7. Turn the manual adjuster clockwise from the maximum recommended pressure for the system and count the turns required to bottom out. By using the number of turns per 1000 PSIG calculated in step 5, an estimate of the maximum pressure setting of the valve can be determined. Remove or add shims (12, Figure 7).This will increase or decrease the pressure setting to cartridge valve specifications. See Tables 10, 12 and 13. NOTE: Adding shims increases pressure setting.

8. If the cartridge pressure reducing valve uses a micrometer knob or a micrometer knob with keylock, return to the appropriate step (section VI-I.11.d or VI-I.12.d). Remove rollpin (6) and adjusting rod (9). Complete assembly of the knob.

C. CALIBRATION OF THE PRESSURE REDUCING VALVE MODULE

NOTE

Pressure calibration of the module will follow exactly the procedures developed for the ON TEST STAND and ON VEHICLE testing previously presented. With the exception that an interface cover and directional valve will be required to test the module. The pressure setting of the module must be lower than the pressure setting of the interface cover. Refer to Figures 4/5 and 10 during the adjustment. If an offset (LH) valve is used as the controller, the solenoid must be energized during this adjustment. If a detent type valve is used, the valve should be in the P-A, B-T position.

Litho in U.S.A.

LABORATORY WORKSHOP

CARTRIDGE VALVES IN CONJUNCTION WITH THE FLUID POWER TRAINER

I. To reciprocate the horizontal cylinder using a meter-out type speed control for control in both directions.

A. Assemble inserts and covers in manifold as shown in Figure #1. Note: That valve #1 and valve #4 require dampener inserts and stroke limiting covers.

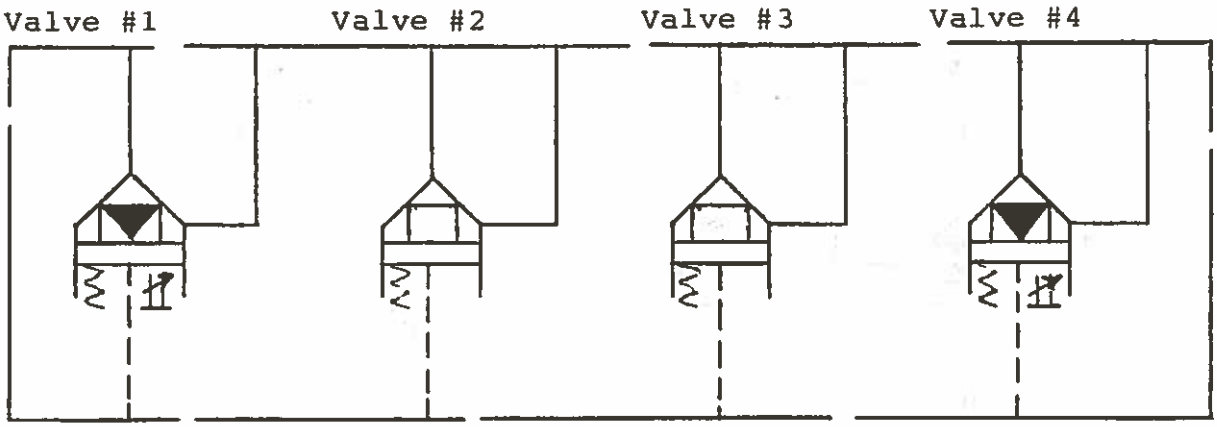
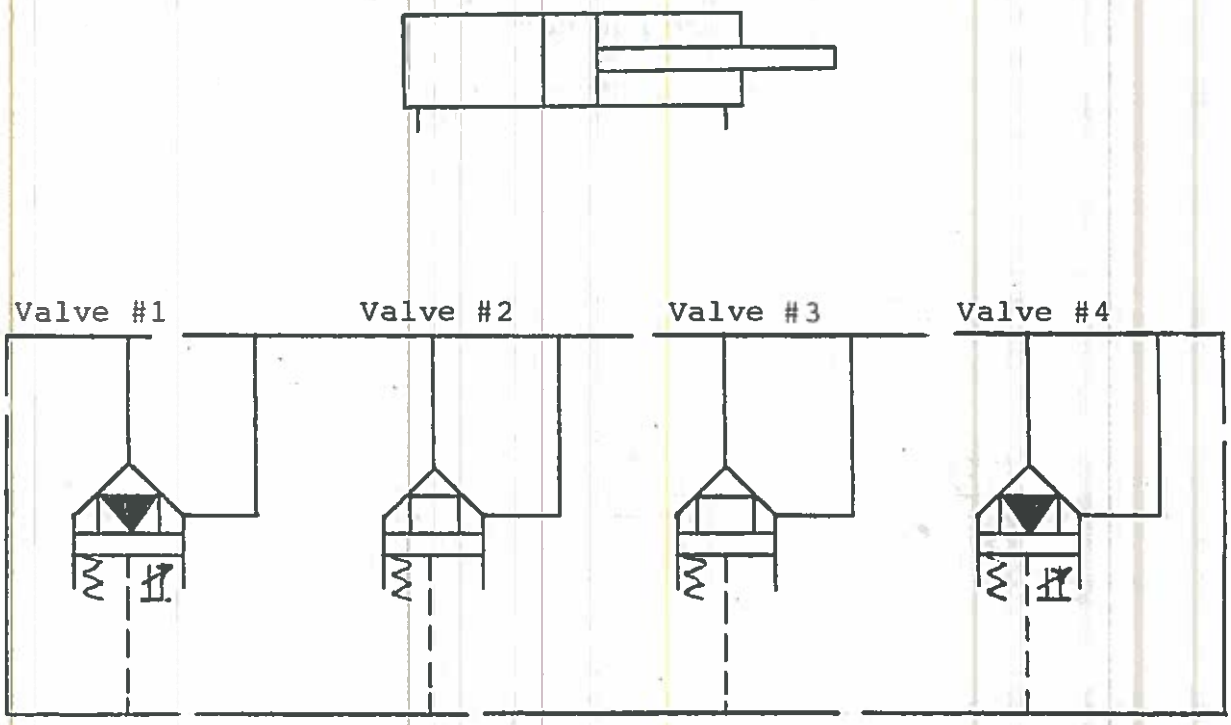


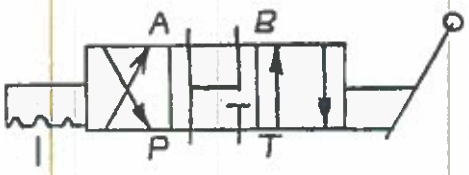
Figure #1

B. Complete the drawing shown in Figure #2. The purpose of the circuit is to reciprocate the horizontal cylinder.

C. Place the cartridge valve manifold on the hydraulic trainer tray directly beneath the hydraulic trainer manifold. Connect the circuit as you have drawn it. Before start up, back out the stroke limiter adjusting screws to permit maximum piston rod velocity. Observe piston rod velocity in both directions.

D. Adjust stroke limiting controls decreasing the piston rod velocity in both directions.


Valve #1
Valve #2
Valve #3
Valve #4


A
B
P
T

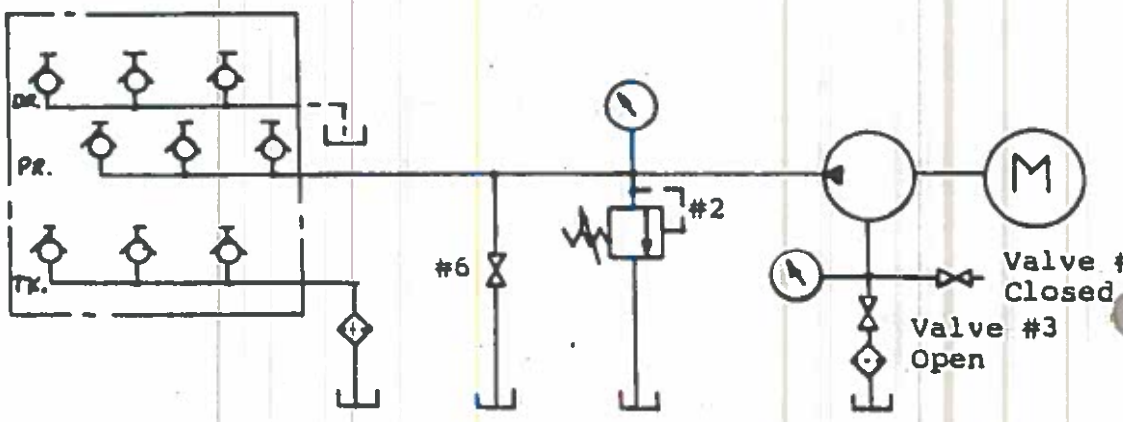
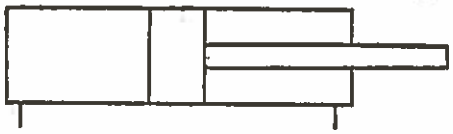
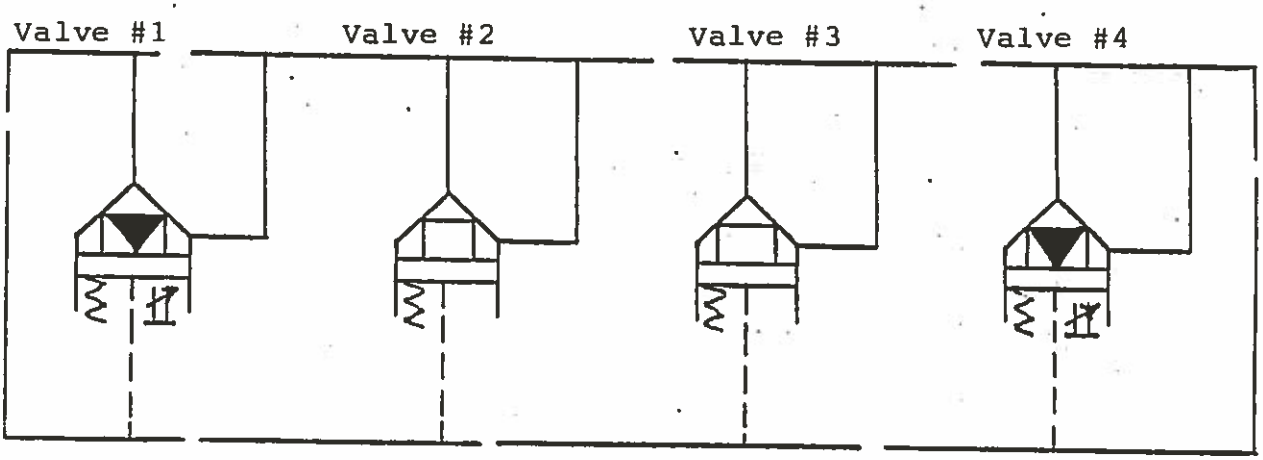
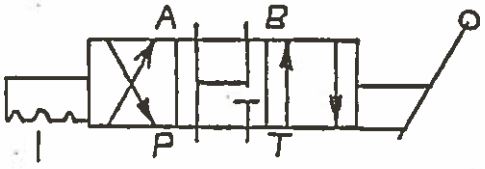

DR.
PR.
TK.
#6
#2
M
Valve #4
Closed
Valve #3
Open

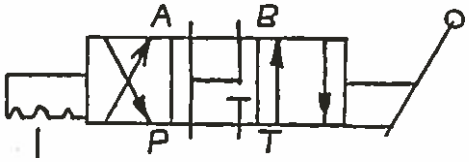
Figure #2

II. Complete the drawing in Figure #3.
Problem - With the addition of a second directional control valve arrange the circuit to permit regenerative advance with changeover to conventional.









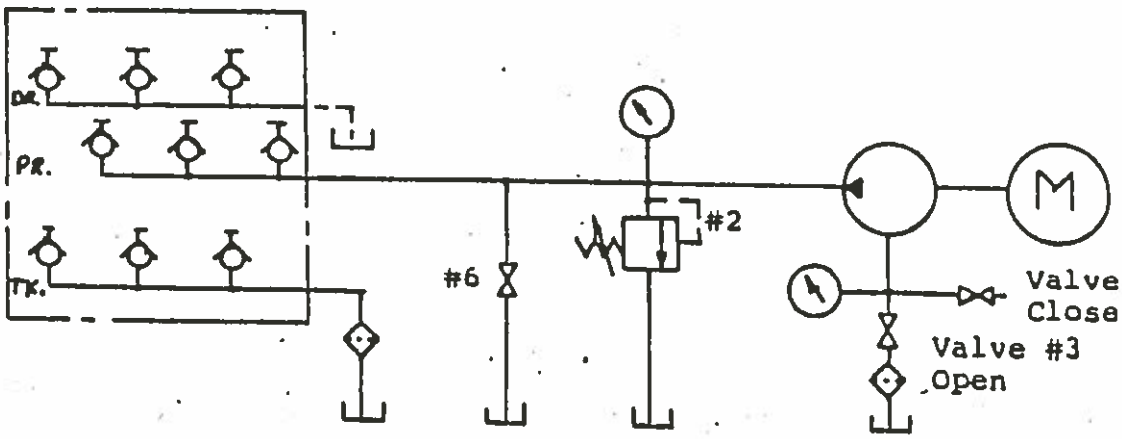


Figure #3

A. Indicate the four equivalent directional valve spool positions in this circuit. Graphic symbols.

B. Remove and hang up the hoses. Leave the manifold on the trainer for future use. Thank you.

VICKERS

CLASSROOM PROBLEM

CARTRIDGE VALVES

Poppet cracking pressures with pressure applied to 'A' port 'AP' area drained.			
SPRING TYPE	AREA RATIOS		
	1:1	1:1.1	1:2
Light		0.3 bar	0.5 bar
Medium		1.4 bar	2.5 bar
Heavy	2.5 bar	2.7 bar	5.0 bar

Given the following parameters, will the valve be open or closed?

a. Area ratio 1:2
Spring Light
A port pressure (bar) 50
B " " " 52
X " " " 50

B. Area ratio 1:1.1
Spring Light
A port pressure (bar) 50
B " " " 52
X " " " 50

C. Area ratio 1:2
Spring Heavy
A port pressure (bar) 4.0
B " " " 4.0
X " " " 0.0

D. Area ratio 1:1
Spring Heavy
A port pressure (bar) 1.0
B " " " 20.0
X " " " 00.0

CHAPTER 12

ACCESSORIES

This chapter deals with various accessories used to perform special functions in hydraulic systems. The subjects covered are accumulators, intensifiers, pressure switches and instruments.

ACCUMULATORS

Unlike gases the fluids used in hydraulic systems cannot be compressed and stored for usage at a different time or place. Where it can be used to advantage an accumulator provides a means of storing these incompressible fluids under pressure. It does so because of the fact that as the hydraulic fluid under pressure enters the accumulator chamber it does one of three things: it compresses a spring, it compresses a gas, or it raises a weight. Any tendency for pressure to drop at the inlet causes the element to react and force the fluid back out.

WEIGHT-LOADED ACCUMULATOR

The earliest type of accumulator built was the weight-loaded design (Fig. 12-1). A vertical ram or piston has provision for adding or removing weights to vary the pressure. Pressure is always equal to the weight imposed divided by the piston or ram area exposed to the hydraulic fluid. This is the only type of accumulator where pressure is constant, whether the chamber is full or nearly empty. Weight-loaded accumulators, however, are heavy and bulky and their use is limited. They may be found on some

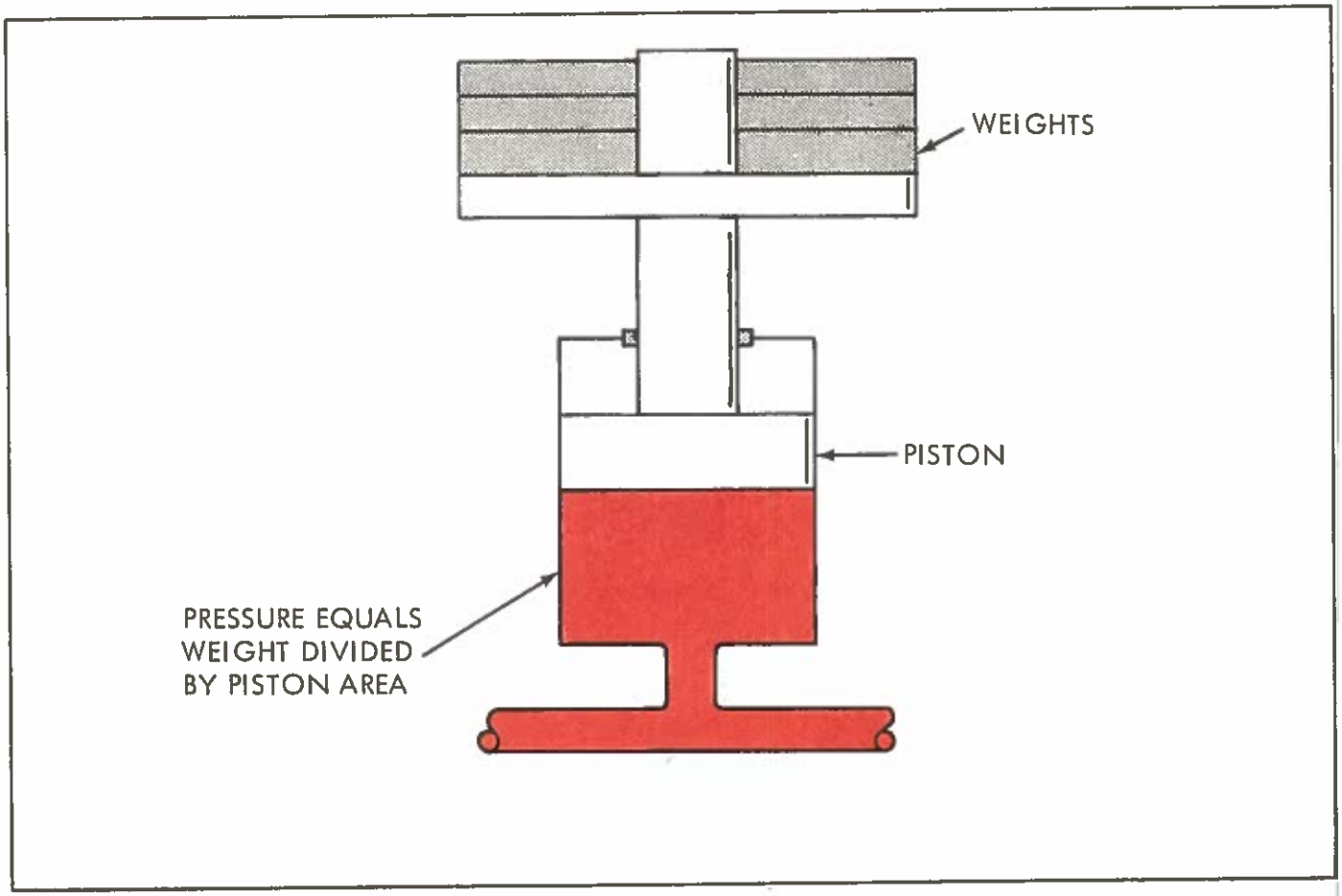


Fig. 12-1. Weighted Accumulator Produces Constant Pressure

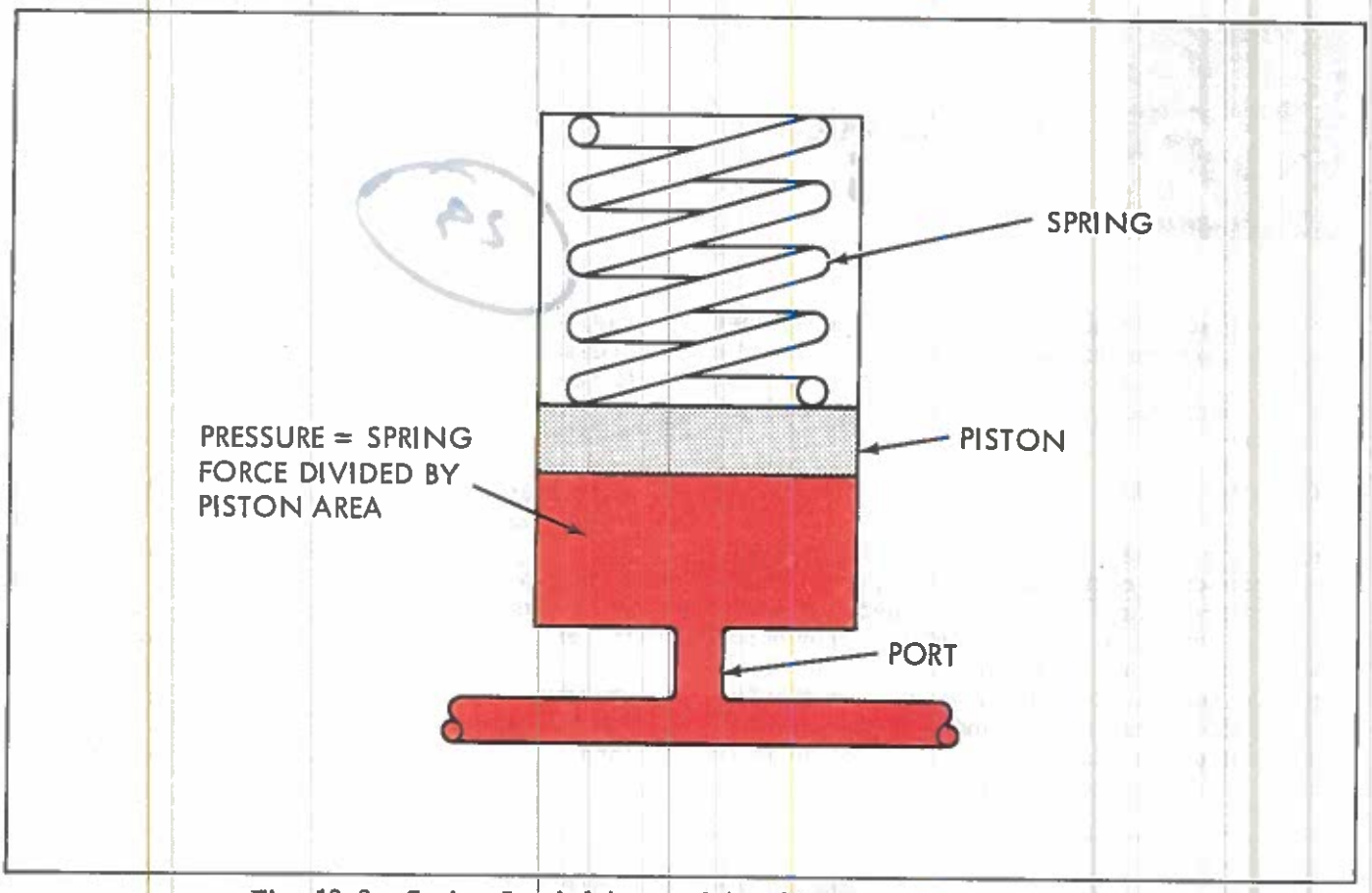


Fig. 12-2. Spring-Loaded Accumulator does not Require Charging

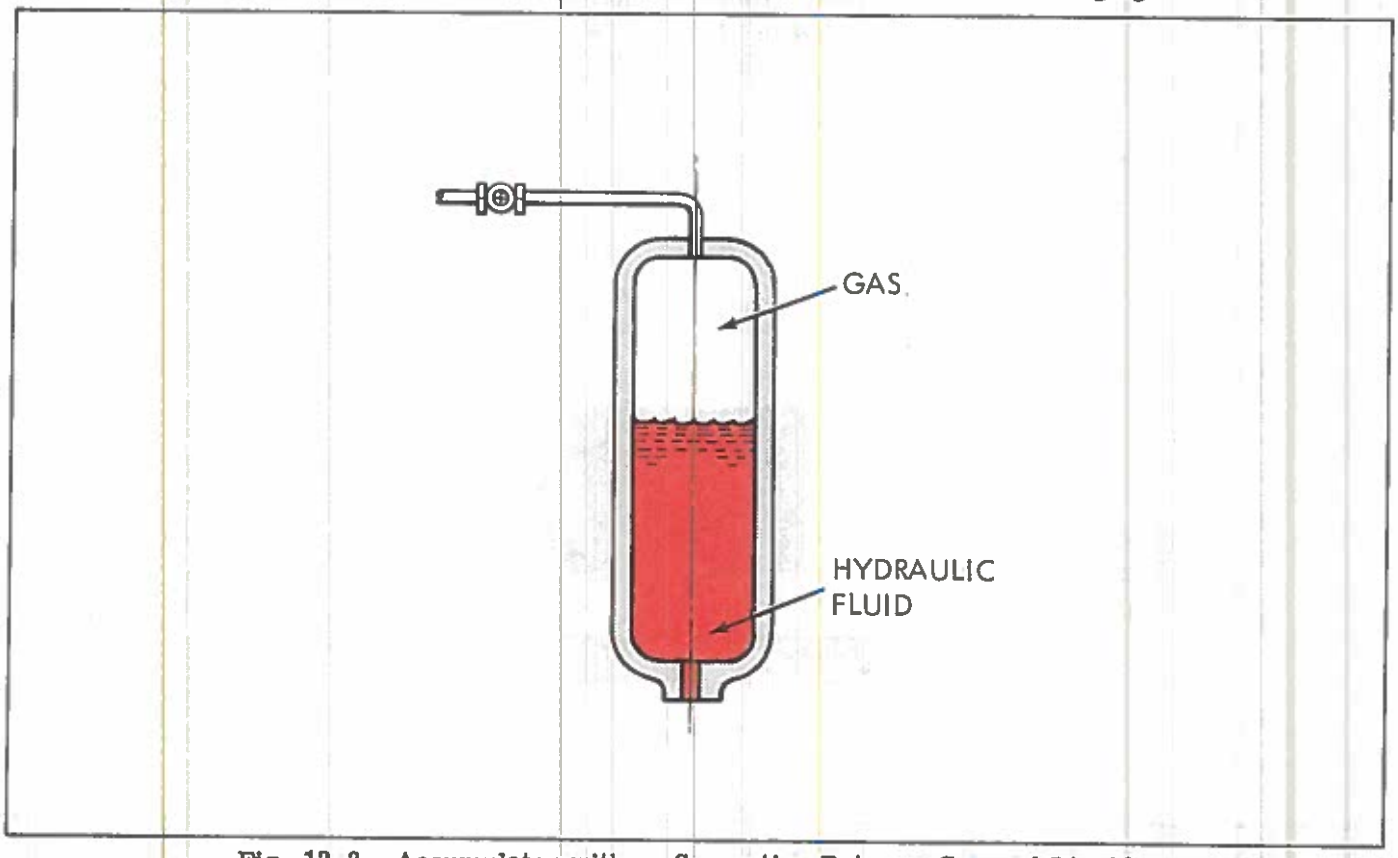


Fig. 12-3. Accumulator with no Separation Between Gas and Liquid

heavy presses where constant pressure is required or in applications where unusually large volumes are necessary.

SPRING-LOADED ACCUMULATORS

In a spring loaded accumulator (Fig. 12-2), pressure is applied to the fluid by compression of a coil spring behind the accumulator piston. The pressure is equal to the instantaneous spring force divided by the piston area.

$$\text{Pressure} = \frac{\text{Spring Force}}{\text{Area}}$$

Where: Spring Force = Spring Constant x (Compression Distance)

The pressure therefore is not constant since the spring force increases as fluid enters the chamber and decreases as it is discharged.

Spring loaded accumulators can be mounted in any position. The spring force, i. e., the pressure range is not easily adjusted, however, and where large quantities of fluid are required the forces involved would make spring sizes impractical.

GAS CHARGED ACCUMULATOR

Probably the most commonly used accumulator is one in which the chamber is pre-charged with an inert gas, usually dry nitrogen. Oxygen should never be used because of its tendency to burn or explode under compression with oil. While air is sometimes used, it is not recommended for the same reason.

A gas charged accumulator should be precharged while empty of hydraulic fluid. Precharge pressures vary with each application and depends upon the working pressure range and volume of fluid required within that range. It should never be less than 1/4 and preferably 1/3 of maximum working pressure. Accumulator pressure varies in proportion to the compression of the gas, increasing as fluid is pumped in and decreasing as it is expelled.

No-Separator Type

Figure 12-3 shows an accumulator with no separator between the hydraulic fluid and the charging gas. Frequently used on diecast machines it must be mounted vertically. It is important to select a pressure volume relationship such that not more than 2/3 of the oil is ever used in operation to avoid accidental discharge of gas into the system.

Diaphragm or Bladder Type

Many accumulators incorporate a synthetic rubber diaphragm or bladder (Fig. 12-4), to contain the gas precharge and separate it from the hydraulic fluid. Since certain fire resistant fluids may not be compatible with conventional diaphragm or bladder materials it is important that proper selection be made.

Available oil can vary between 1/4 and 3/4 of total capacity depending upon operating conditions. Operation outside these limits can cause the separator to stretch or wrinkle and shorten its life.

Piston Type Accumulator

Another method of separating the gas charge from the hydraulic fluid is by means of a free piston (Fig. 12-5). Similar in construction to a hydraulic cylinder the piston under pressure of the gas on one side constantly tries to force the oil out of the opposite side of the chamber. Here too pressure is a function of the compression and varies with the volume of oil in the chamber.

APPLICATIONS

In many hydraulic systems, a large volume of fluid is required to do the work, but the work is done only intermittently in the machine cycle. For example, in die casting, the "shot" cylinder must be moved very rapidly when the piece is being formed, but is idle while the piece is being removed and during the mold closing and opening phases. Rather than use a very high volume pump intermittently, such a system stores fluid from a relatively small volume pump in an accumulator and discharges it during the "shot" portion of the cycle.

Another application is where it is necessary to maintain pressure for extended periods of time. Instead of allowing the pump to run constantly at the relief valve setting, it is used to charge an accumulator. The pump can then be unloaded freely to tank while the accumulator maintains pressure. Pressure switches or unloading valves are used to recycle the pump periodically to replace fluid lost through leakage or valve actuation.

Accumulators may also be installed in a system to absorb shock or pressure surges due to the sudden stopping or reversing of oil flow. In such cases the pre-charge is close to or slightly above maximum operating pressure allowing it to "pick off" pressure peaks without constant or extended flexing of the diaphragm or bladder.

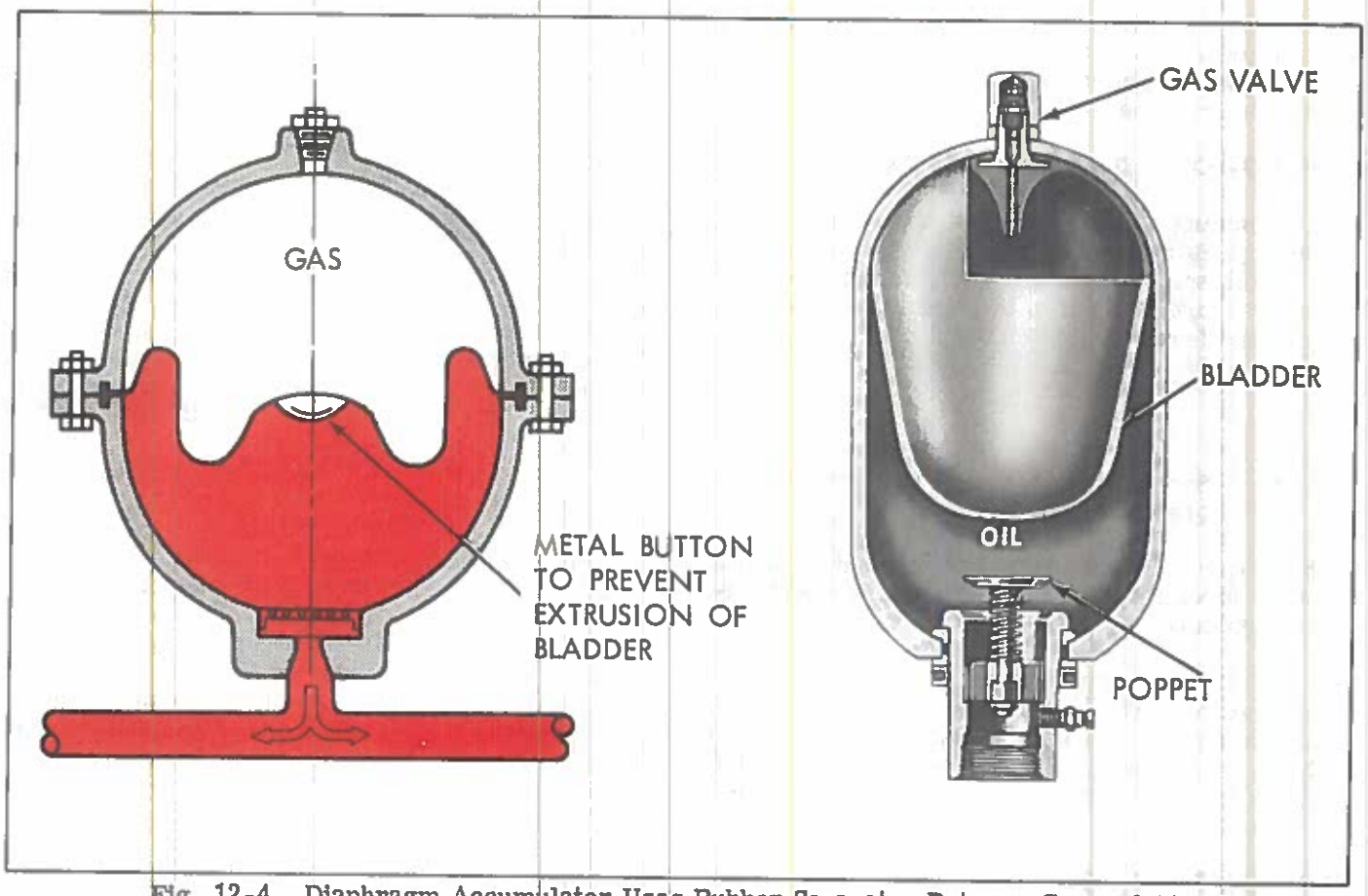


Fig. 12-4. Diaphragm Accumulator Uses Rubber Separator Between Gas and Liquid

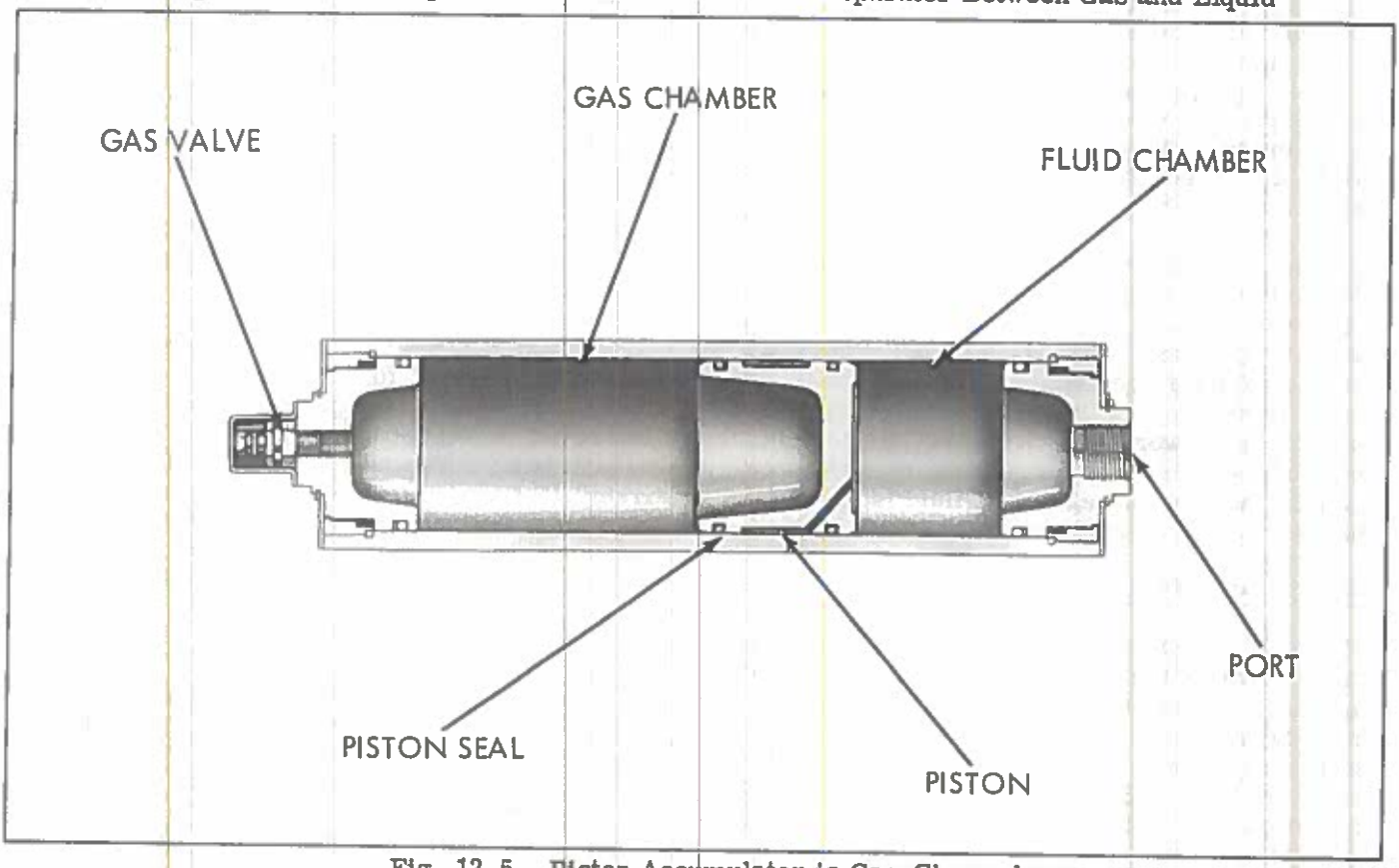


Fig. 12-5. Piston Accumulator is Gas-Charged

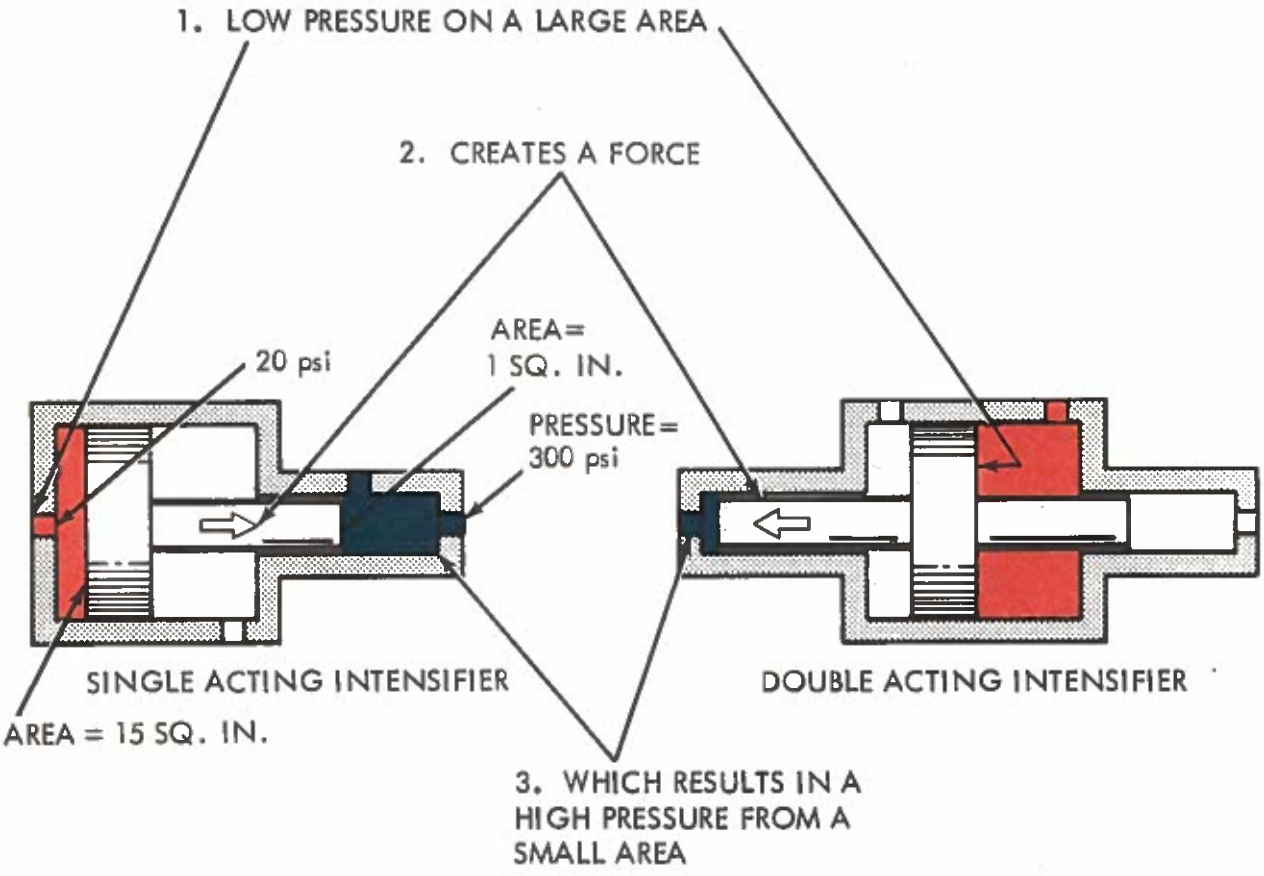


Fig. 12-6. Intensifier "Boosts" Pressure

As a word of caution the accumulator must be blocked out of the circuit or completely discharged before attempting to disconnect any hydraulic lines. Never try to disassemble an accumulator without releasing the pre-charge whether it be gas, weights, or springs.

INTENSIFIERS

An intensifier is a device used to multiply pressure.

In certain applications such as riveters or piercing machines a small amount of oil at high pressure may be required for the final portion of the work cylinder travel. An intensifier can develop pressures several times higher than what can be developed by the pump. In figure 12-6 pressure on the large area exerts a force which requires a considerably higher pressure on the small area to resist it. Pressure increase is in inverse proportion to the area ratios. The volume of fluid discharged at high pressure will, however, be proportionately less than that required at the large end.

PRESSURE SWITCHES

Pressure switches (Fig. 12-7) are used to make or break (open or close) electrical circuits at selected pressures to actuate solenoid operated valves or other devices used in the system.

The operating principle of a pressure switch is shown in Figure 12-8. This design contains two separate electrical switches. Each is operated by a push rod which bears against a plunger whose position is controlled by hydraulic and spring forces. The pressure at which the switches operate is selected by turning the adjusting screw to increase or lessen the spring force.

It should be noted that in this design the switches are actuated by the springs when the unit is assembled. Thus the normally open contacts are closed and vice versa.

When the preset pressure is reached the plunger will compress the spring and allow the push rods to move down causing the snap action switches to revert to their normal condition.

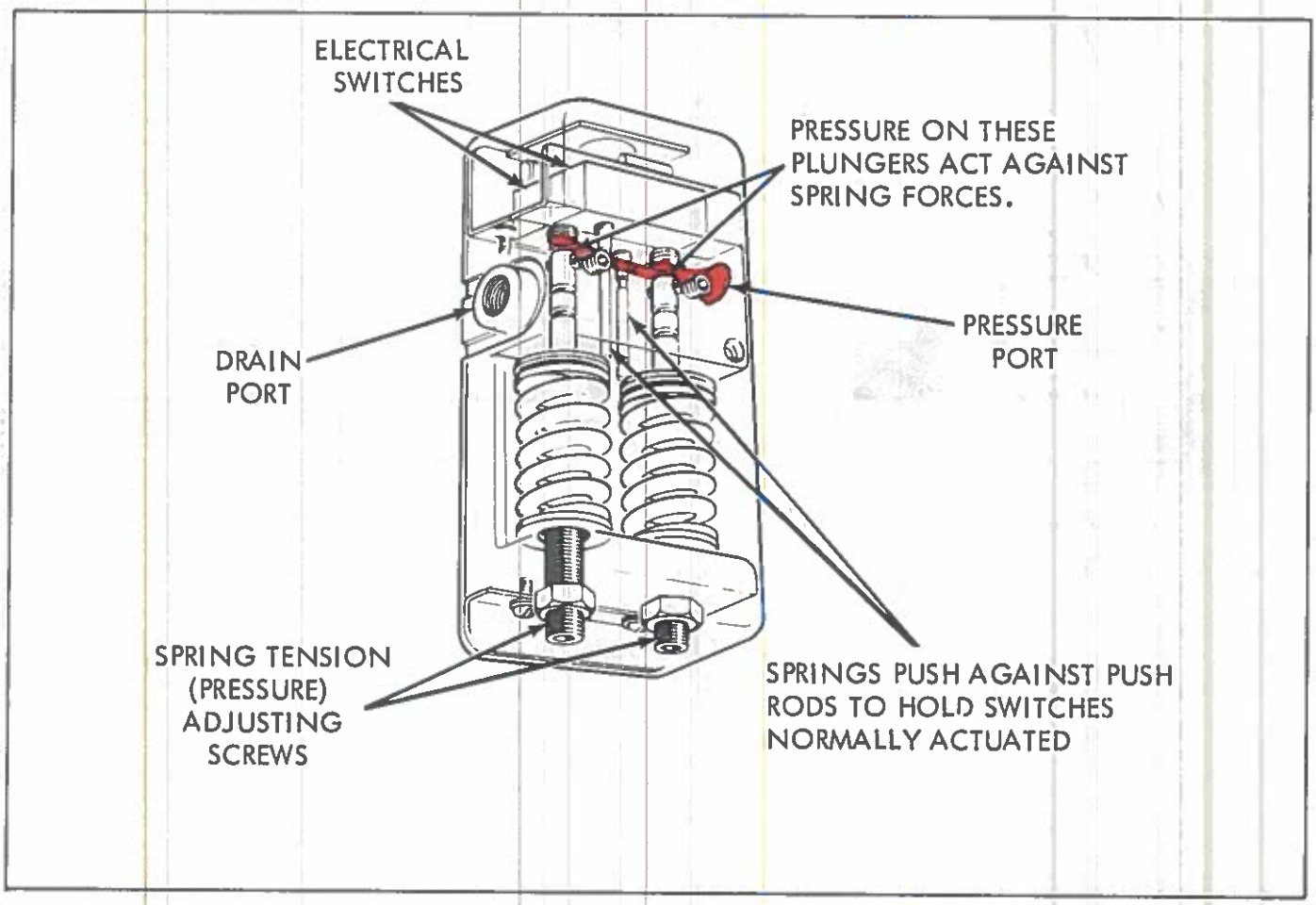

ELECTRICAL SWITCHES
PRESSURE ON THESE PLUNGERS ACT AGAINST SPRING FORCES.
PRESSURE PORT
DRAIN PORT
SPRING TENSION (PRESSURE) ADJUSTING SCREWS
SPRINGS PUSH AGAINST PUSH RODS TO HOLD SWITCHES NORMALLY ACTUATED

Fig. 12-7. Typical Pressure Switch

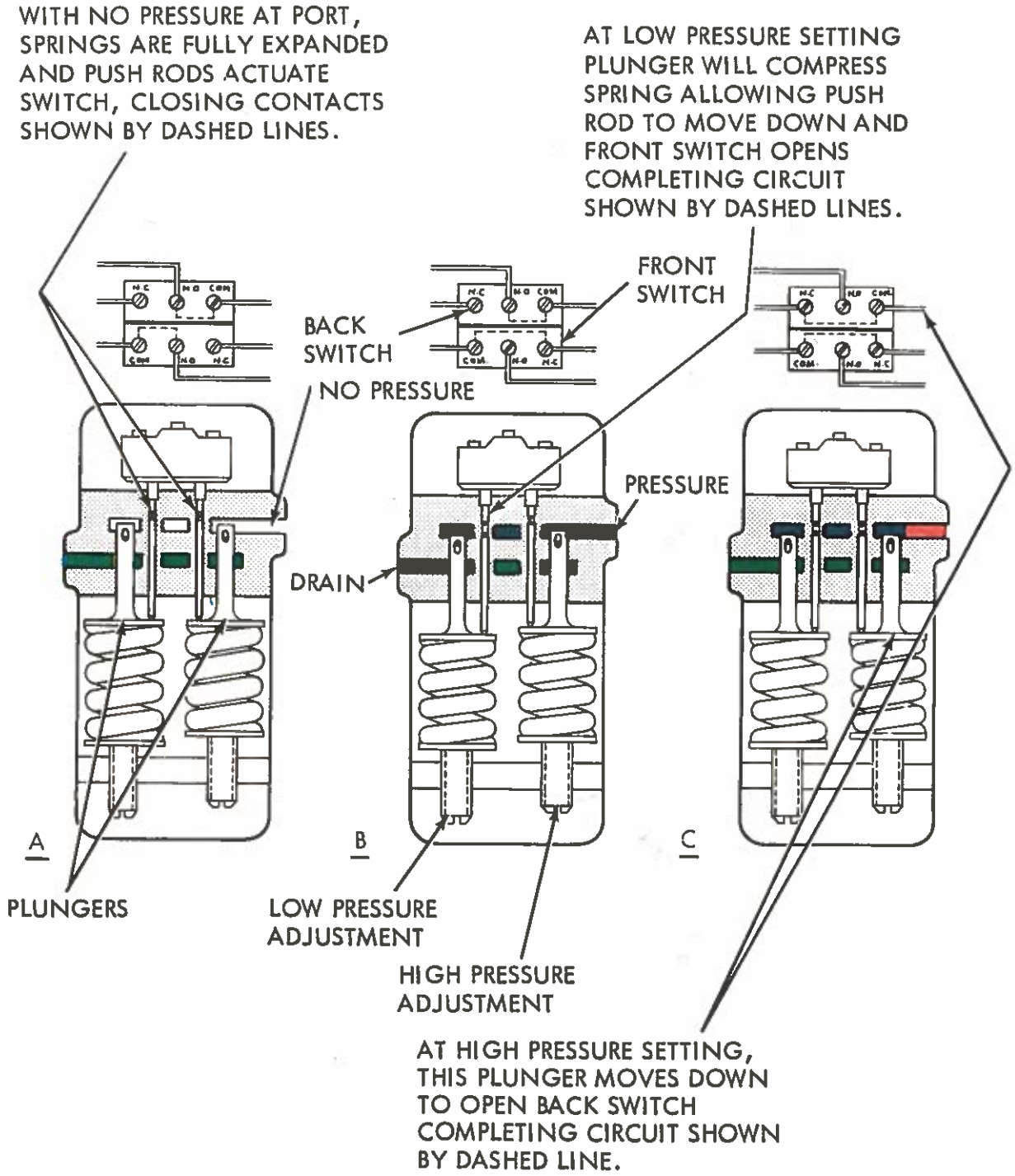

WITH NO PRESSURE AT PORT, SPRINGS ARE FULLY EXPANDED AND PUSH RODS ACTUATE SWITCH, CLOSING CONTACTS SHOWN BY DASHED LINES.
AT LOW PRESSURE SETTING PLUNGER WILL COMPRESS SPRING ALLOWING PUSH ROD TO MOVE DOWN AND FRONT SWITCH OPENS COMPLETING CIRCUIT SHOWN BY DASHED LINES.
FRONT SWITCH
BACK SWITCH
NO PRESSURE
PRESSURE
DRAIN
A
B
C
PLUNGERS
LOW PRESSURE ADJUSTMENT
HIGH PRESSURE ADJUSTMENT
AT HIGH PRESSURE SETTING, THIS PLUNGER MOVES DOWN TO OPEN BACK SWITCH COMPLETING CIRCUIT SHOWN BY DASHED LINE.

Fig. 12-8. Pressure Switch Operation

By using both switches in conjunction with an electrical relay, system pressures may be maintained within widely variable high and low ranges.

INSTRUMENTS

Flow rate, pressure and temperature measurements are required in evaluating the performance of hydraulic components. All three can be helpful too in setting up or trouble-shooting a hydraulic system. Due to the difficulty in installing a flow meter in the circuit, flow measurements are often determined by timing the travel or rotation of an actuator. Pressure and temperature are determined in the usual manner by means of gauges and thermometers.

Pressure Gauges

Pressure gauges are needed for adjusting pressure control valves to required values and for determining the forces being exerted by a cylinder or the torque of a hydraulic motor.

Two principal types of pressure gauges are the Bourdon tube and Schrader types. In the Bourdon tube gauge (Fig. 12-9), a sealed tube is formed in an arc. When pressure is applied at the port opening, the tube tends to straighten. This actuates linkage to the pointer gear and moves the pointer to indicate the pressure on a dial.

In the Schrader gauge (Fig. 12-10), pressure is applied to a spring-loaded sleeve and piston. When pressure moves the sleeve, it actuates the gauge needle through linkage.

Most pressure gauges read zero at atmospheric pressure and are calibrated in pounds per square inch, ignoring atmospheric pressure throughout their range.

Pump inlet conditions are often less than atmospheric pressure. They would have to be measured as absolute pressure, sometimes referred to as psia, but more often calibrated in inches of mercury with 30 inches of mercury considered a perfect vacuum. A vacuum gauge calibrated in inches of mercury is shown in figure 12-11.

Gauge Installation

It is desirable to incorporate one or more gauge connections in a hydraulic system for convenience in set-up and testing, although gauge ports are included in most relief valves and in some

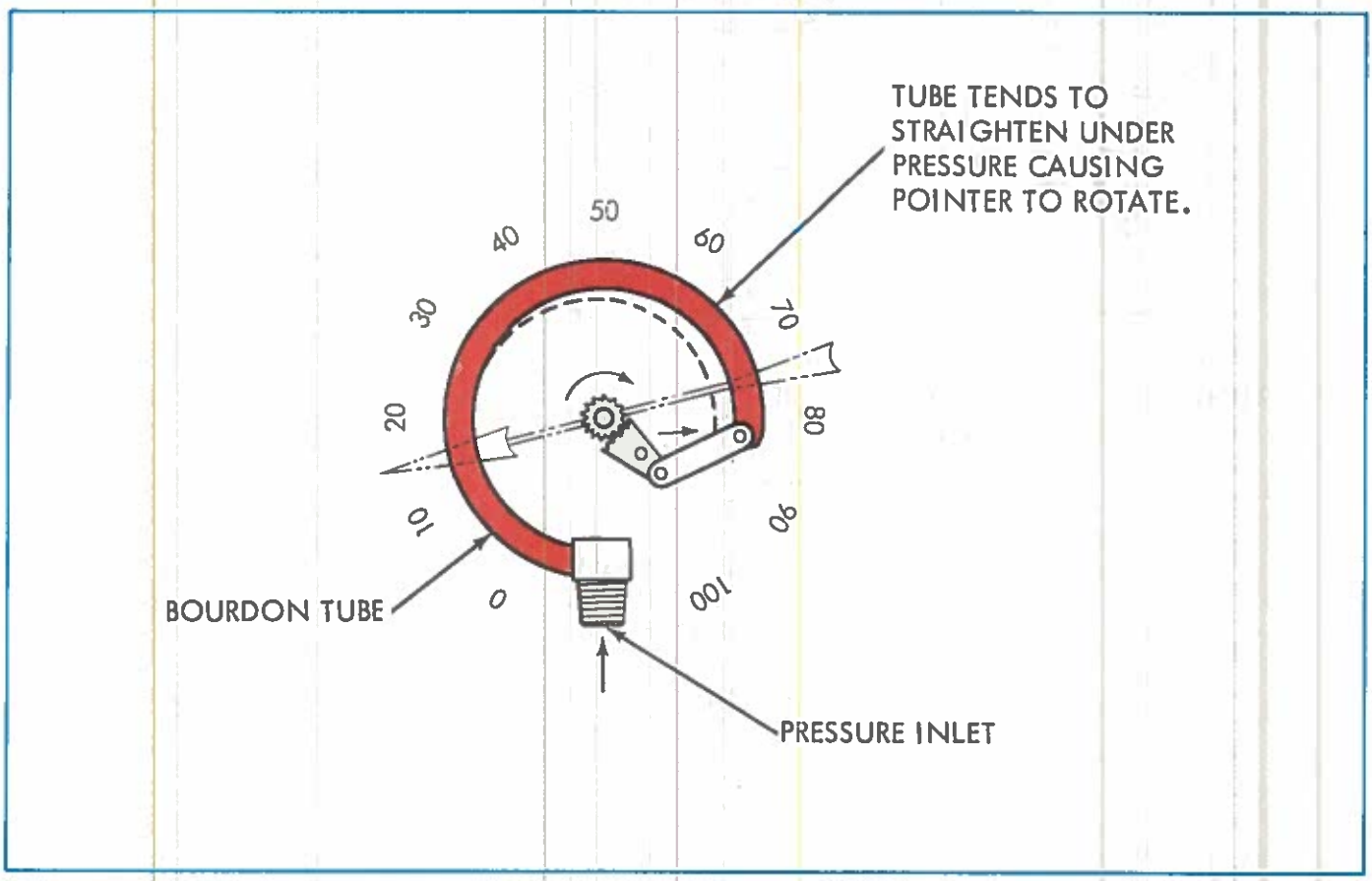


Fig. 12-9. Bourdon Tube Gauge

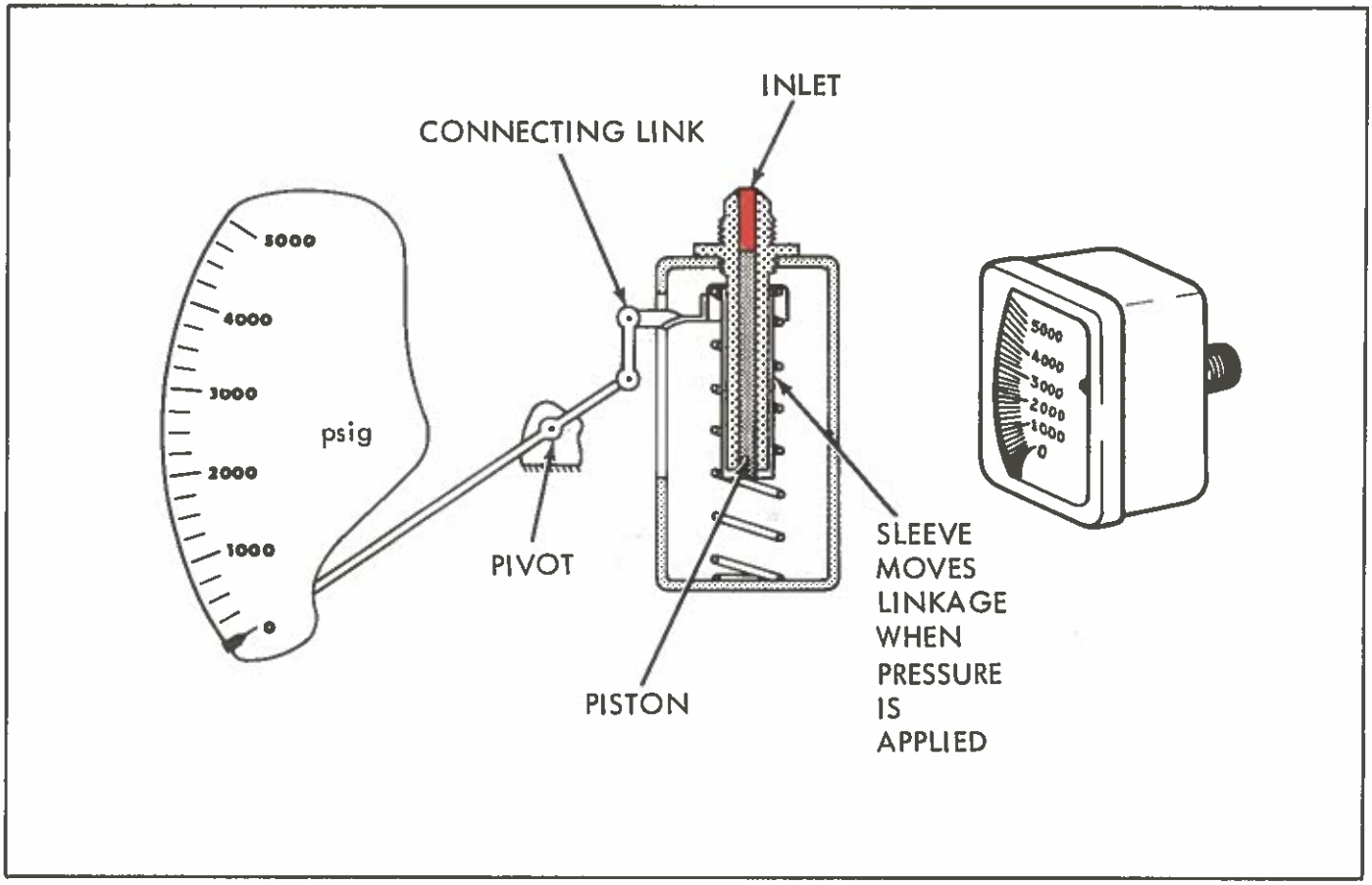


Fig. 12-10. - Schrader Gauge Operation

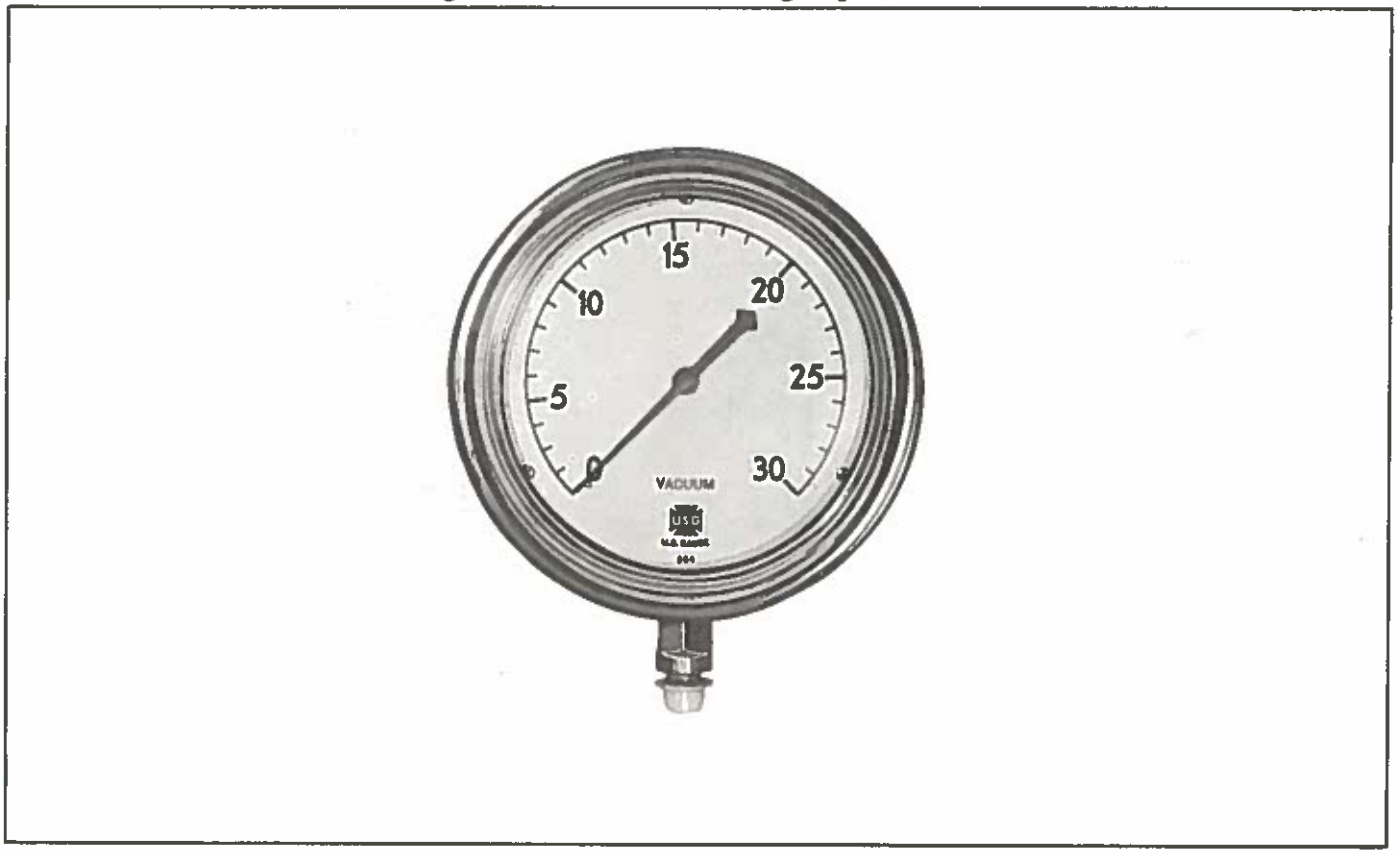


Fig. 12-11. Vacuum Gauge Calibrated in Inches of Mercury

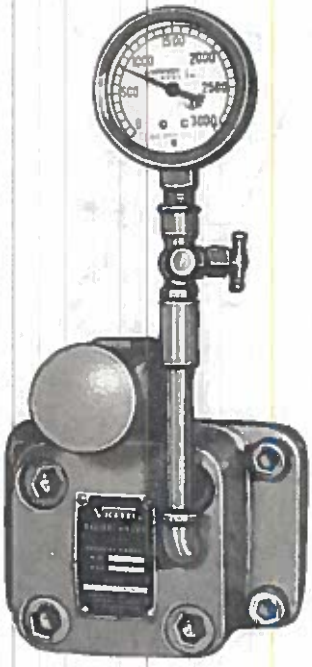


Fig. 12-12. Gauge Installed with Shutoff Valve and Snubber

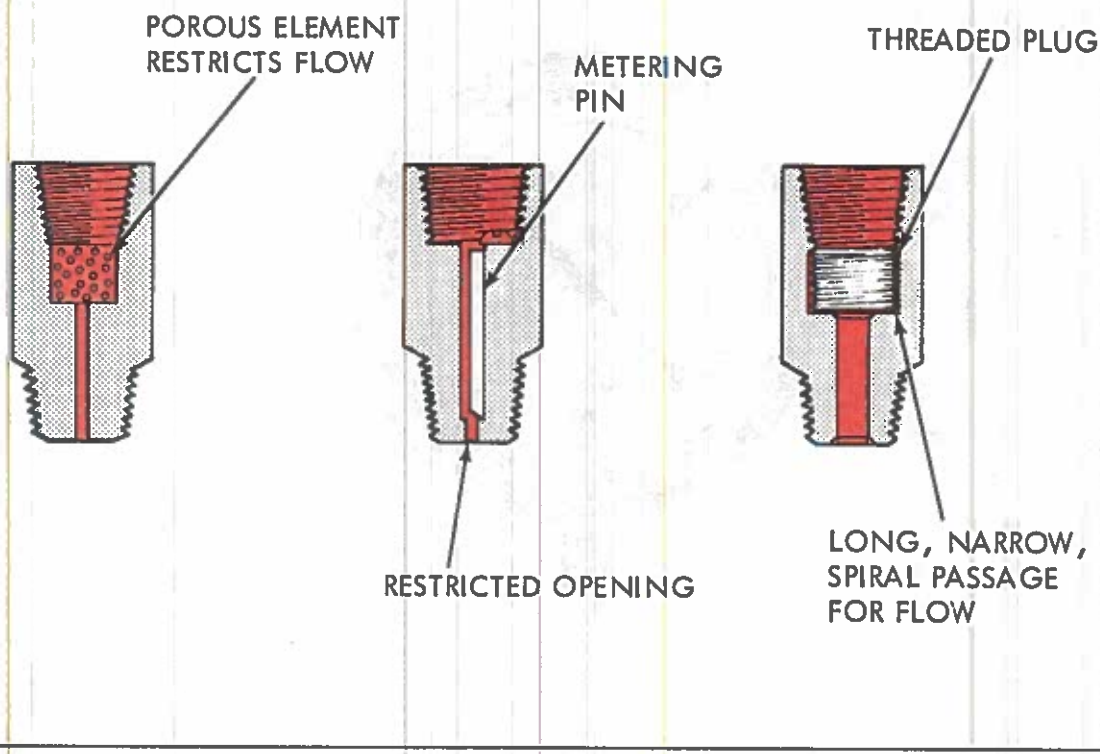


Fig. 12-13. Gauge Snubbers Guard Against Pressure Surges

other hydraulic components. When a gauge is installed permanently on a machine, a shutoff valve and snubber (Fig. 12-12) are usually installed along with it. The shutoff valve prolongs gauge life by isolating it from the system except when it is desired to make a reading. The snubber (Fig. 12-13) prevents the gauge from oscillating and protects it from pressure surges. A small coil (approx. 2" diam.) of 1/8 inch tubing makes an excellent gauge damping device when commercially made units are not available.

Flow Meters

Flow meters are usually found on test stands, but portable units are available. Some include the flow meter, a pressure gauge and thermometer in a single unit (Fig. 12-14). They are seldom, if ever, connected permanently on a machine. However, coupled into the hydraulic piping they are useful in checking the volumetric efficiency of a pump and determining leakage paths within the circuit.

A typical flow meter (Fig. 12-15) consists of a weight in a calibrated vertical tube. Oil is pumped into the bottom and out the top and raises the weight to a height proportional to the flow. For more accurate measurement, a fluid motor of known displacement can be used to drive a tachometer. The gpm flow is:

$$\text{gpm} = \frac{\text{rpm x displacement (cu in./rev)}}{231}$$

Of course, the tachometer can be calibrated directly in gpm as well as rpm.

Another type of flow meter (Fig. 12-16) incorporates what is called a disk piston which when driven by the fluid passing through the measuring chamber develops a rotary motion which can be transmitted through gearing to indicator hands on a dial.

More sophisticated measuring devices are turbine type flow meters which generate an electrical impulse as they rotate and pressure sensing transducers which may be located at strategic points within the system where they send out electrical signals proportional to the pressures encountered. These signals can be calibrated and observed on an oscilloscope or other readout devices. See figure 12-17.

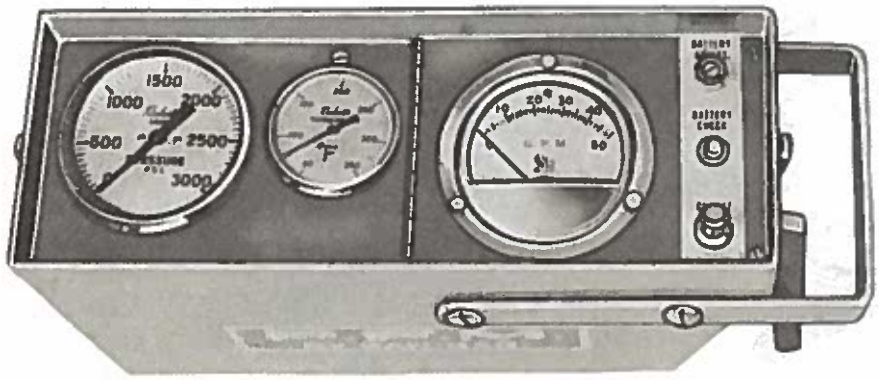


Fig. 12-14. Flow Meter with Pressure Gauge and Thermometer in One Unit

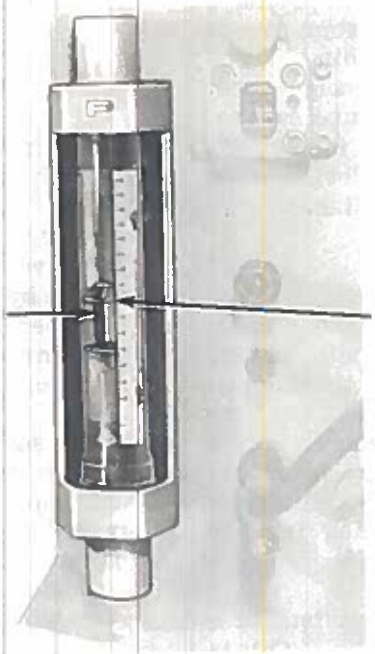


Fig. 12-15. Typical Flow Meter

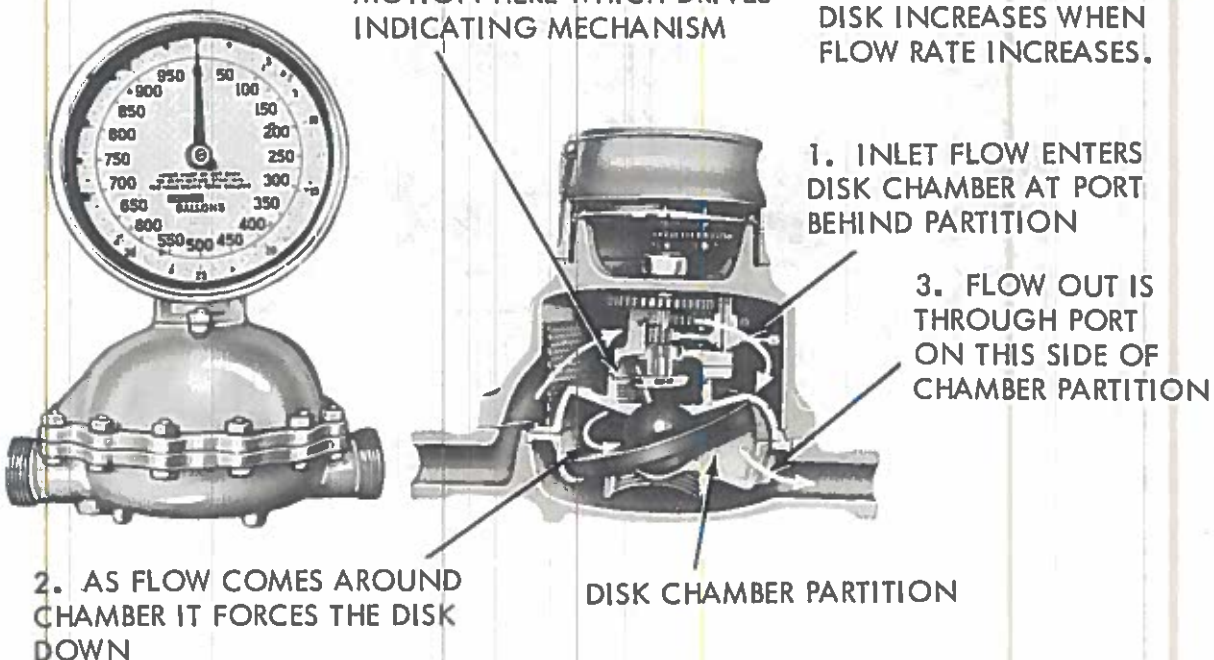

4. WOBBLE ACTION OF DISK IS CONVERTED TO ROTARY MOTION HERE WHICH DRIVES INDICATING MECHANISM
5. RATE OF WOBBLE ON DISK INCREASES WHEN FLOW RATE INCREASES.
1. INLET FLOW ENTERS DISK CHAMBER AT PORT BEHIND PARTITION
3. FLOW OUT IS THROUGH PORT ON THIS SIDE OF CHAMBER PARTITION
2. AS FLOW COMES AROUND CHAMBER IT FORCES THE DISK DOWN
DISK CHAMBER PARTITION

Fig. 12-16. Flow Meter with Disk Piston

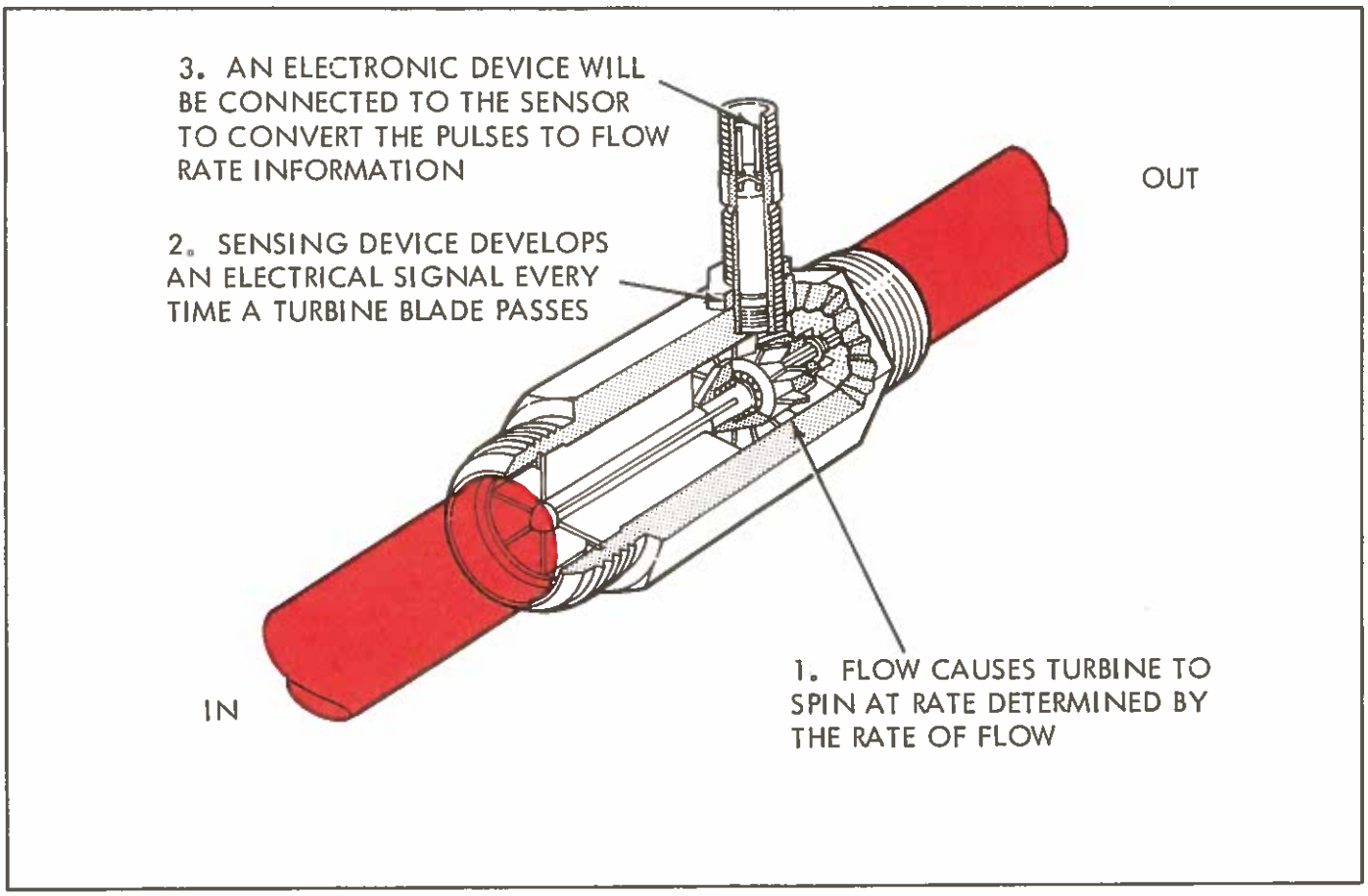

3. AN ELECTRONIC DEVICE WILL BE CONNECTED TO THE SENSOR TO CONVERT THE PULSES TO FLOW RATE INFORMATION
2. SENSING DEVICE DEVELOPS AN ELECTRICAL SIGNAL EVERY TIME A TURBINE BLADE PASSES
OUT
IN
1. FLOW CAUSES TURBINE TO SPIN AT RATE DETERMINED BY THE RATE OF FLOW

Fig. 12-17. Turbine Flow Meter

Such units are found more often in the laboratory, although they, too, are becoming a part of the equipment used by fluid power technicians in setting up and maintaining equipment.

QUESTIONS

1. Name two functions of an accumulator.
2. Which type of accumulator operates at a constant pressure? How can the pressure be changed?
3. How is pressure created in the free-piston accumulator?
4. What type of gas is preferred for gas-charged accumulators?
5. What prevents the bladder from extruding in a bladder type accumulator?
6. What is the purpose of an intensifier?
7. How is a pressure switch operated?
8. Give three situations where a pressure gauge might be required.
9. How are vacuum gauges calibrated?

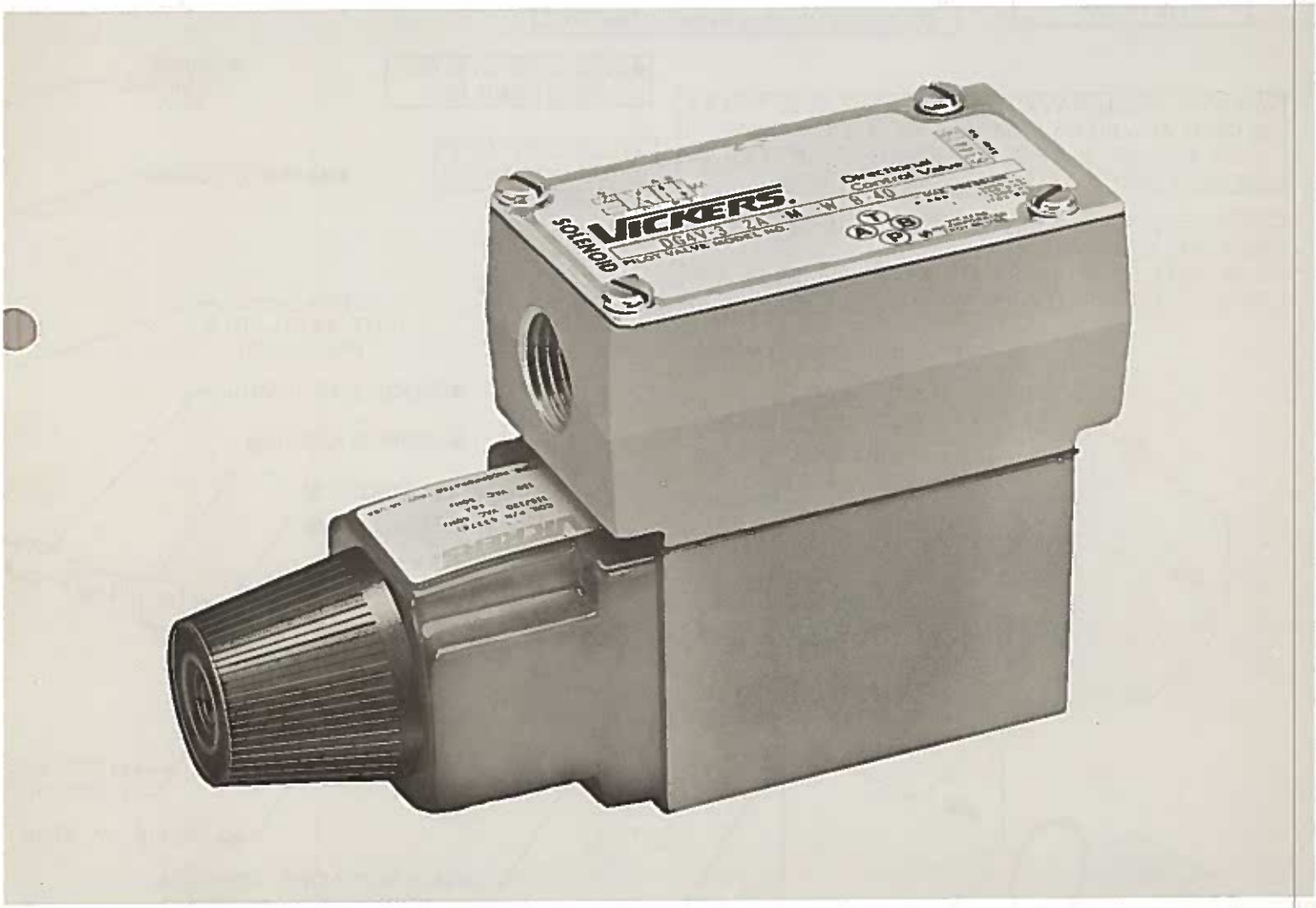
VICKERS

21

Service Parts Information

Solenoid Operated Directional Valve

DG4V-3-*A-M(P**)-**-*-40 Spring Offset



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 7-1-85 I-3861-S

A Libbey-Owens-Ford Company

DIN 43650 COIL S/A	COIL S/A	AC VOLT Hz	DC VOLT	COIL CODE
635061	633741	110/50, 115/60, 120/60	—	B
683312	989721	110/50, 115/60, 120/60		*B-9
635062	633742	220/50, 230/60, 240/60		D
683218	989764	24/50, 24/60		N
683310	683053	100/50, 100/60		T
681611	681404	—	32	DK
681423	989654		12	G
681610	989656		24	H
682552	682550		48	J
*B-9 REDUCED POWER CONSUMPTION COIL				

SPOOL TYPE	SPOOL	■SPOOL KIT
0A	989594	926350
2/28A	631615	926351
6A	989595	926352
7A	989596	926353
22A	989649	926354
SPOOL KIT ALSO INCLUDES PARTS PREFIXED WITH ▲ AND ■ .		

●■▲633746 GASKET/ RETAINER

REFER TO I-3866-S FOR ELECTRICAL FEATURES AND OPTIONS

PARTS PREFIXED WITH SYMBOLS AVAILABLE ONLY IN KITS

●OMIT WHEN USING MODELS WITH DIN 43650 COILS.

✤SUFFIX SYMBOL PERTAINS ONLY TO VICKERS MATERIAL CONTROL

●◆36212 SCREW

◆INCLUDED IN 926433 FASTENER KIT

●630855 TERMINAL BCX

-A SPOOL DESIGNATION OF 28A INDICATES VALVE IS USED AS A PILOT FOR TWO STAGE VALVES WITH 4 OR 8 TYPE MAIN STAGE SPOOLS. REFER TO DWGS. J-682451 & J-685777 FOR NAMEPLATE.

▲INCLUDED IN F3 SEAL KIT 920304

●■▲635069 GASKET

-ASSEMBLE TYPE 0A SPOOL WITH LONGER SPOOL END TOWARDS SOLENOID.
-ASSEMBLE TYPE 7A SPOOL WITH REDUCED AND UNSLOTTED END DIA. TOWARDS SOLENOID.

631604 BODY (NOT AVAILABLE FOR SALE)

DIN 43650 COIL MATING RECEPTACLES (NOT SHOWN)
710776 'A' SOLENOID (GRAY L. H.)
710775 'B' SOLENOID (BLACK R. H.)

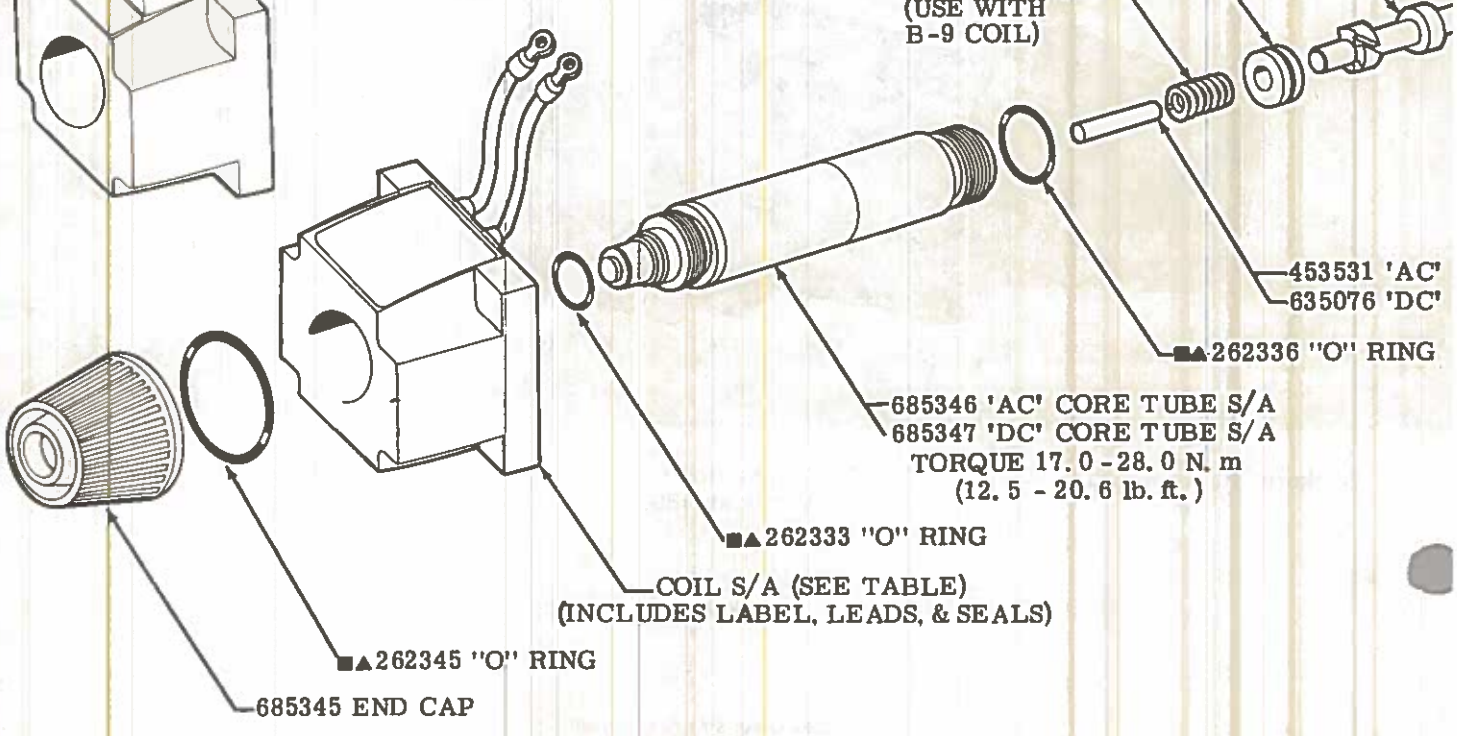
■SPOOL (SEE TABLE)

■627800 WASHER✤

■635313 SPRING✤

989712 SPRING✤ (USE WITH B-9 COIL)

DIN 43650 COIL S/A (SEE TABLE) (INCLUDES LABEL)



453531 'AC'
635076 'DC'

■▲262336 "O" RING

685346 'AC' CORE TUBE S/A
685347 'DC' CORE TUBE S/A
TORQUE 17.0 - 28.0 N. m
(12.5 - 20.6 lb. ft.)

■▲262333 "O" RING

COIL S/A (SEE TABLE)
(INCLUDES LABEL, LEADS, & SEALS)

■▲262345 "O" RING

685345 END CAP

DG4V-3-*A-M(P**)-**-*-40

SCREW (METRIC)	
◆STD (4 REQ'D)	DIN 43650 (2 REQ'D)
422004	468641
TORQUE 0.5-0.7 N. m (4.5 - 6.2 lb. in.)	

989583 SEAL (2 REQ'D) (NOT SHOWN)(WHEN USING 468641 SCREW FOR DIN 43650 MODELS)

635067 CARRIER (STD MCDELS)
989585 CARRIER (DIN 43650)

NAMEPLATE LABEL
(STD MODELS REFER TO DWG. J-682451)
(DIN 43650 REFER TO DWG. J-685777)

●◆473714 SCREW (2 REQ'D)
(TORQUE 2.3 - 2.8 N. m)
(20.3 - 24.8 lb. in.)
(METRIC)

●◆576915 SCREW

634235 END CAP
(TORQUE 17.0-28.0 N. m)
(12.5 - 20.6 lb. ft.)

■▲262336 "O" RING

■▲676560 PLUG

■635313 SPRING✤

989712 SPRING✤
(USE WITH B-9 COIL)

"P" FEATURE MANUAL OVERRIDE

■▲262332 "O" RING

676271 PLUNGER✤

■▲262336 "O" RING

676270 END CAP
(TORQUE 17.0-28.0 N.m)
(12.5 - 20.6 lb. ft.)

472553 ROLLPIN✤

IN✤
IN✤

RESTRICTOR PLUG
(OPTIONAL)(SEE TABLE)

■▲262332 "O" RING (4 REQ'D)

RESTRICTOR PLUG		
PART	ORIFICE DIA.	
	mm	inches
684300	0.3	.012
631892	0.8	.032
628733	1.0	.040
632937	1.3	.052
635281	1.5	.060
687072	2.0	.080
631931	2.3	.092
685482	3.2	.128
632936	BLANK	
USE IN EITHER A, B, P, OR T PORT		

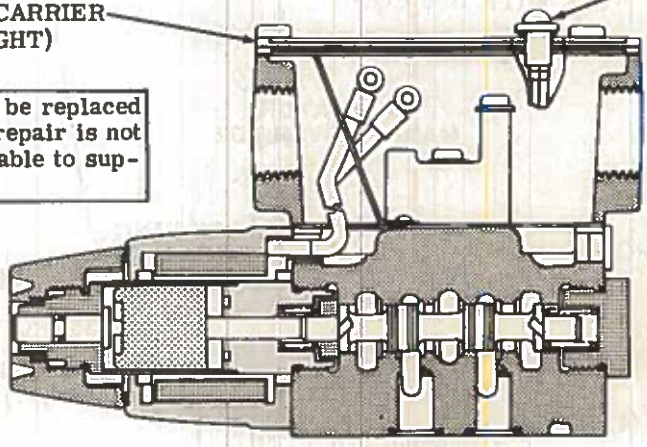
RIGHT HAND ASSEMBLY SHOWN, EXCEPT 28A(P). FOR LEFT HAND ASSEMBLY, ALL PARTS ARE REVERSED, EXCEPT BODY AND TERMINAL BOX.

MODEL CODE BREAKDOWN

DG4V-3- * A(P)(L)-M(P)-**-*-(9)-(***)-40**

- DIRECTIONAL VALVE
- SUBPLATE OR MANIFOLD MOUNTED
- SOLENOID OPERATED
- MAXIMUM PRESSURE RATING 350 bar (5000 PSI)
- INTERFACE NFPA-D01/ ISO-4401-3
- SPOOL TYPE
- A - SPRING OFFSET TO 'A' PORT
- MANUAL OVERRIDE (OMIT WHEN NOT REQUIRED)
- LEFT HAND (OMIT WHEN NOT REQ'D)
- FLAG SYMBOL HEADING ELECTRICAL FEATURES AND OPTIONS
- ELECTRICAL FEATURES (REFER TO DWG. I-3866-S)
- U - DIN 43650 COIL
  W - WIRING HOUSING ½ NPT THD.
  WL - WIRING HOUSING ½ NPT THD. (WITH INDICATOR LIGHT)
- COIL CODE LETTER (SEE TABLE FOR VOLTAGE AND FREQUENCY)
- LOW WATTAGE COIL (B COIL ONLY)
- RESTRICTOR PLUG (A, B, P, OR T PORT) (SEE TABLE FOR ORIFICE DIA. SIZES)
- DESIGN

635065 CARRIER (LIGHT)



LIGHT KIT	VOLTAGE RANGE
926499	12V AC/DC
926431	24V AC/DC
926432	115V AC/DC
926458	230V AC/DC

LIGHT KITS INCLUDE TWO LIGHTS

As this complete unit can be replaced at a nominal cost, factory repair is not practical. Kits are available to support customer repair.

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

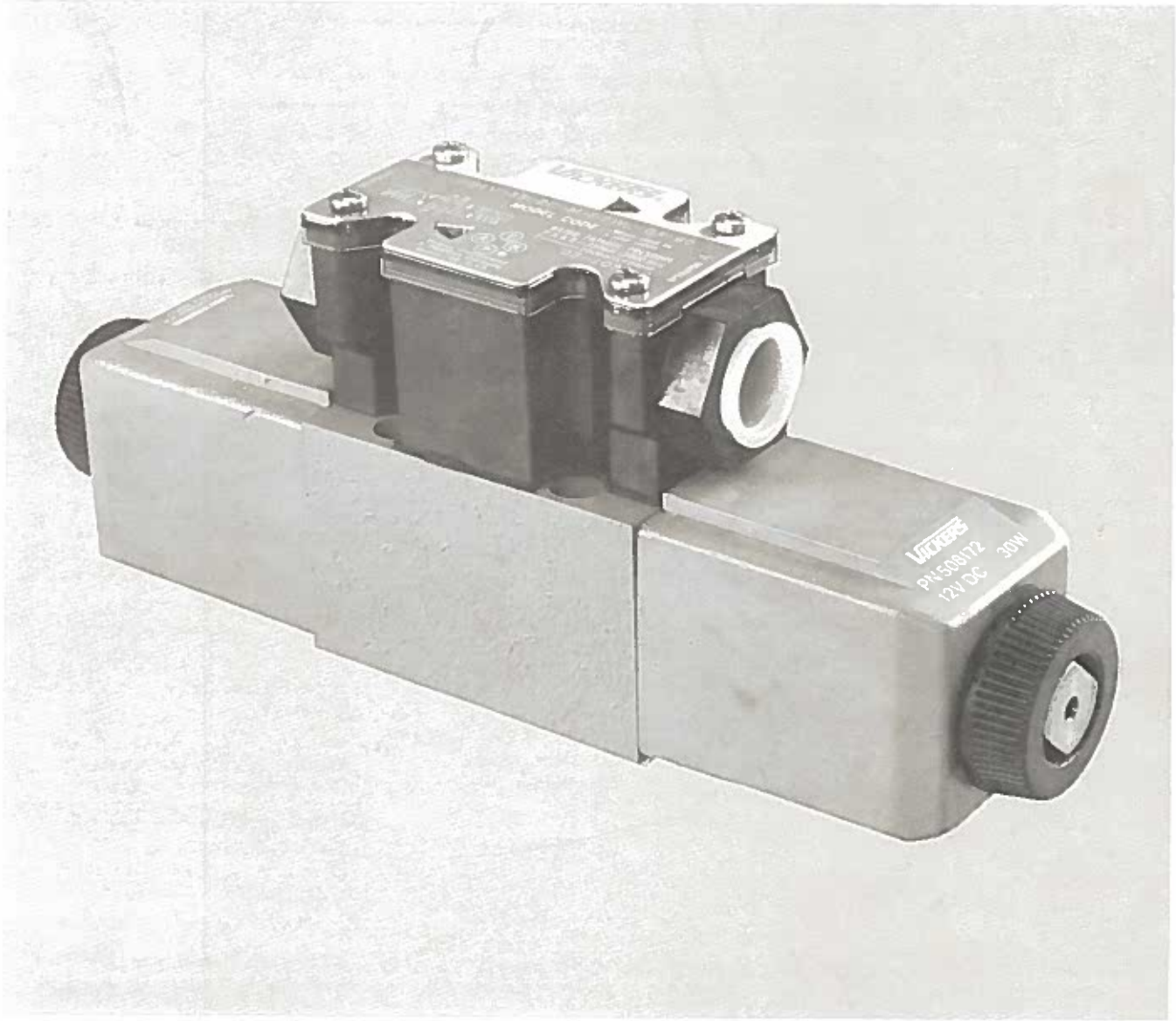
Litho in U. S. A.

Service Data

VICKERS

CETOP 3 Size Soft Shift Directional Control Valves

DG4V-3S-***2**(L)-**-(V)M-******(L)-**5-60-(P**-A**-B**-T**)



Vickers Incorporated
A TRINOVA Company
5445 Corporate Drive
P. O. Box 302
Troy, Michigan 48007-0302
U.S.A.

Revised 12-01-91

I-3894-S

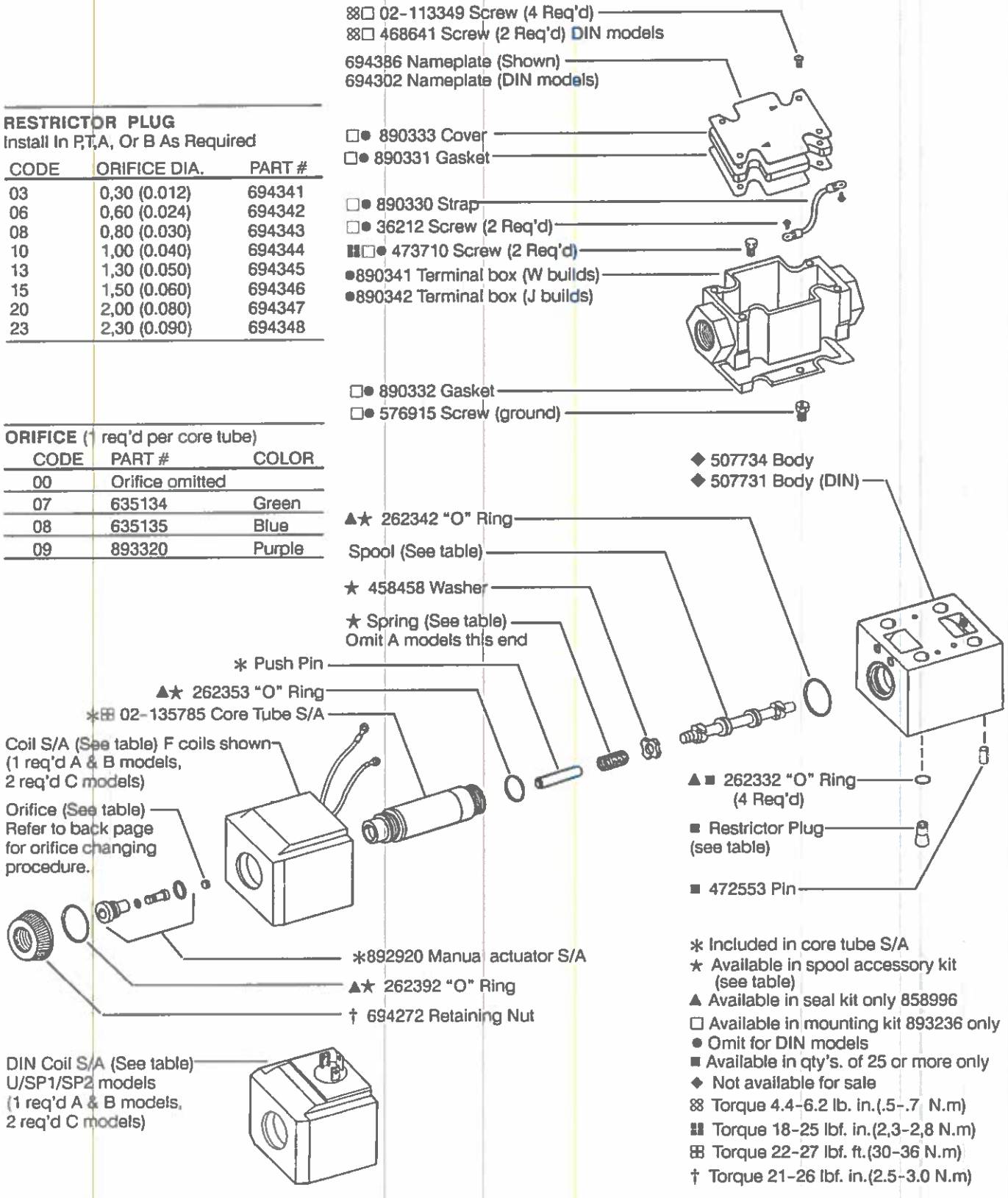
MODEL	SPOOL	TYPE	SPRING	★ ACCESSORY KIT
-**B/C	892913	2*	507889	697365
	892914	6*	694299	697366
	893319	8*	694299	697366
	892915	33*2	507889	697365
-**A	892916	2A	507889	697365

RESTRICTOR PLUG
Install In P,T,A, Or B As Required

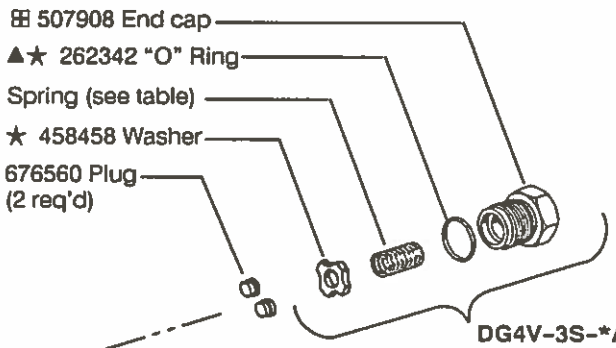
CODE	ORIFICE DIA.	PART #
03	0,30 (0.012)	694341
06	0,60 (0.024)	694342
08	0,80 (0.030)	694343
10	1,00 (0.040)	694344
13	1,30 (0.050)	694345
15	1,50 (0.060)	694346
20	2,00 (0.080)	694347
23	2,30 (0.090)	694348

ORIFICE (1 req'd per core tube)

CODE	PART #	COLOR
00	Orifice omitted	
07	635134	Green
08	635135	Blue
09	893320	Purple



∗ Included in core tube S/A
★ Available in spool accessory kit (see table)
▲ Available in seal kit only 858996
□ Available in mounting kit 893236 only
● Omit for DIN models
■ Available in qty's. of 25 or more only
◆ Not available for sale
⊠ Torque 4.4-6.2 lb. in.(.5-.7 N.m)
▪▪ Torque 18-25 lbf. in.(2,3-2,8 N.m)
⊞ Torque 22-27 lbf. ft.(30-36 N.m)
† Torque 21-26 lbf. in.(2.5-3.0 N.m)

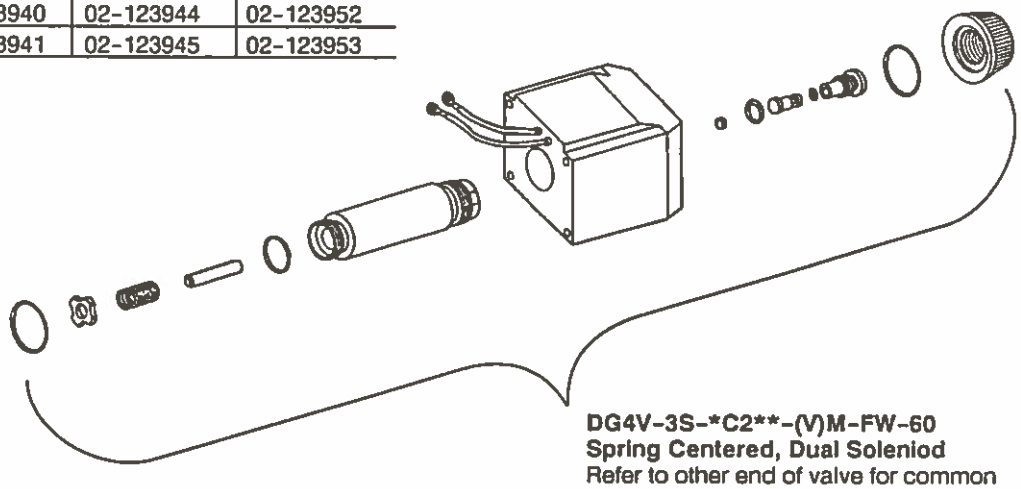


NOTE
See service drawing I-3886-S for options.

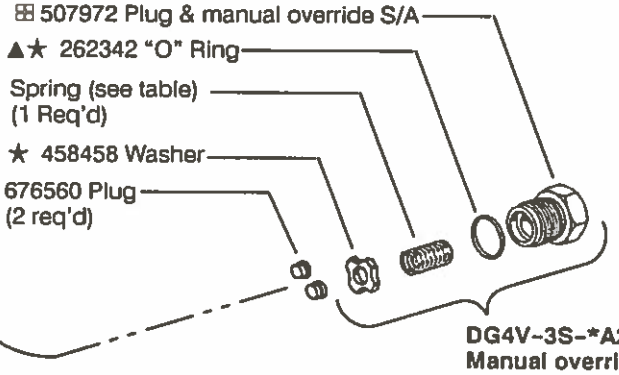
DG4V-3S-*A2(L)**-(V)M-FW-60**
Spring offset to CYL. "A", shift to center

DG4V-3S-*B2(L)**-(V)M-FW-60**
Spring Centered, Sol. "A" Removed
Refer to other end of valve for common part numbers except as noted.

COIL-LETTER	COIL S/A F MODELS	COIL S/A U MODELS	COIL S/A SP2 MODELS	COIL S/A SP1 MODELS
GH	02-123958	02-123938	02-123942	02-123950
HH	02-123959	02-123939	02-123943	02-123951
DJH	02-123960	02-123940	02-123944	02-123952
PH	02-123961	02-123941	02-123945	02-123953



DG4V-3S-*C2-(V)M-FW-60**
Spring Centered, Dual Soleniod
Refer to other end of valve for common part numbers except as noted.



NOTE
For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. OFP, OFR, and OFRS series filters are recommended.

DG4V-3S-*A2-*P2-(L)**-(V)M-FW-60**
Manual override in end cap
Refer to other end of valve for common part numbers except as noted.

NOTE
Right hand assembly shown for all single solenoid valves, for left hand assembly all parts are reversed except body.

Model code

DG4V – 3 S – * *(L) 2 ** – * – (V) M – * * * * (L) – * H 5 – 60 – (P*–A*–B*–T*)

1 | 2 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 12 13 14 | 15 | 16 17 18 | 19 | 20

1 Valve type
D – Directional control valve
G – Subplate mounted
4 – Solenoid operated
V – Rated pressure (350 bar)

2 Interface
3 – ISO 4401-03, CETOP 3 (NFPA D03)

3 Standard performance

4 Spool types
2 – Closed center (all ports)
6 – Closed center (P only)
8 – Tandem center (open crossover)
33 – Closed center (Bleed A & B)

5 Spool/spring arrangement
A – Spring offset, single solenoid
AL – Spring offset, single solenoid (Left hand build)
B – Spring centered, single solenoid
BL – Spring centered, single solenoid (Left hand build)
C – Spring centered

6 Soft shift valve

7 Soft shift orifice size
00 – No orifice
07 – .7 mm
08 – .8 mm
09 – .9 mm

8 Manual override
Blank – Override in solenoid end only
P2 – Manual override in end cap and solenoid, A & B models only

9 Solenoid energization identity
Blank – ANSI B93 energize solenoid A to give flow P to A
V – Solenoid identification determined by position of solenoid (i.e. solenoid A is at port A end of valve, Solenoid B is at port B end of valve.)

10 Flag symbol
(Introduces electrical features and options)

11 Coil types
F – Flying lead type coils
U – DIN 43650 coils
SP1 – Single 1/4" male spade ISAE J858A type 1A
SP2 – Dual 1/4" male spade ISAE J858A type 1A

12 Coil connectors
("U" type coils only, omit if not required)
1 – Connector fitted
6 – Connector with lights fitted
11 – Rectifier with lights fitted
12 – Rectifier fitted

13 Electrical connections
("F" type coils only, omit if not required)
PA – Insta-plug male recpt. only
PA3 – 3 pin receptacle
PA5 – 5 pin receptacle
PB – Insta-plug male & female recpt.
T – Terminal block

14 Wiring housing thread
("F" type coils only, omit if not required)
W – 1/2 NPT
J – M20 x 1.5

15 Solenoid indicator lights
(Not available on PA, U, SP1, SP2, omit if not required)

16 Coil identification letter
G – 12V DC
H – 24V DC
DJ – 98V DC
P – 110V DC

17 Soft shift coil identification

18 Tank pressure rating
5 – 100 bar (1450 psi)

19 Design number

20 Port orifices
e.g. "P08" – 0.8 mm orifice in P port (omit it not required)
03 – 0.30 dia.
06 – 0.60 dia.
08 – 0.80 dia.
10 – 1.0 dia.
13 – 1.3 dia.
15 – 1.5 dia.
20 – 2.0 dia.
23 – 2.3 dia.

Orifice changing procedure

WARNING

1. Before breaking a circuit connection make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure. Plug all removed units and cap all lines to prevent entry of dirt into the system.

2. Using a 5/32" hex key, remove manual actuator plug and spring from the end of solenoid (Tightening torque 6.2-7.3 N.m 55-65 lbf.in.)

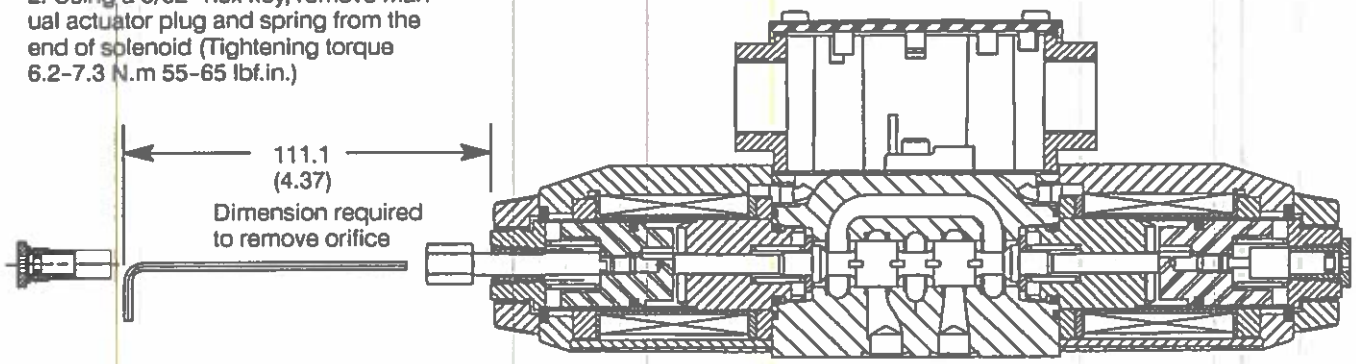
3. Insert extraction tool (878495) into solenoid via the manual actuator opening. Rotate tool until aligned and push pin into slot in armature.

4. Using 1/2" wrench and tool to prevent the armature from rotating, insert 3/32" hex key down the center of tool and remove orifice plug.

5. Replace by the same method, tightening orifice snug to ensure bottoming of threads. Smaller orifices increase response times, larger orifices decrease response time.

Orifice & tool kit 02-140211

For fine tuning shift performance, orifice must be ordered separately. The kit includes (2) each of .7, .8 & .9 mm dia. orifices, (1) installation tool, (1) 5/32" hex key and (1) 3/32" hex key.



The right to modifications for technical improvements is reserved

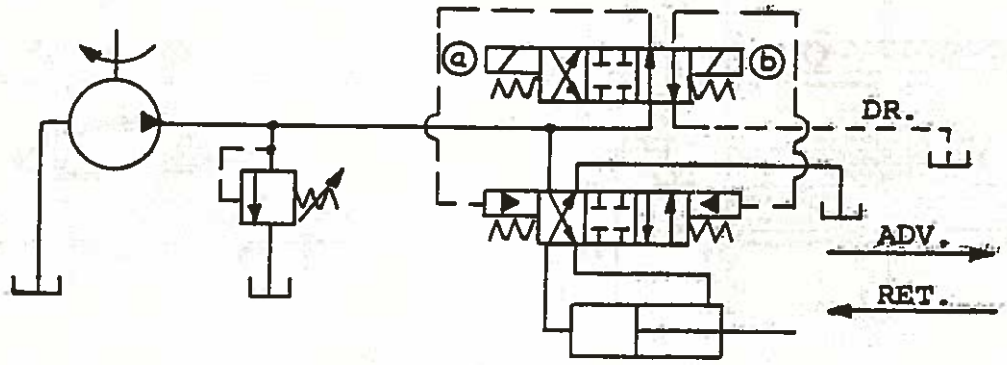
Printed in U.S.A.

CLASSROOM OR HOMEWORK PROBLEM

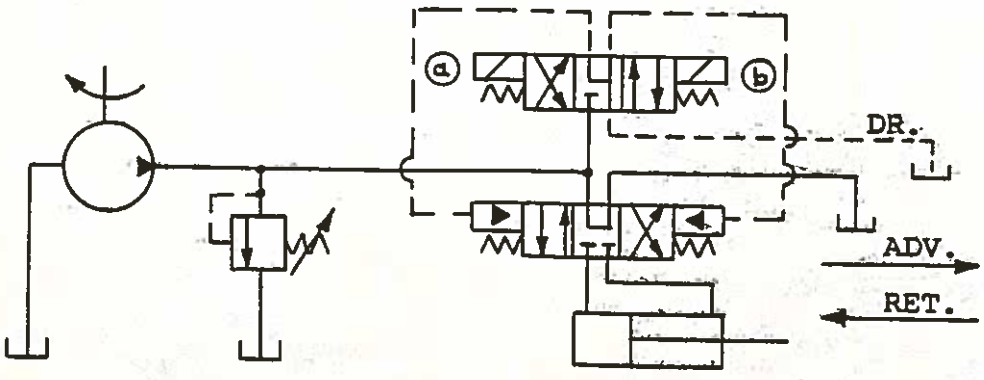
Pilot Operated Directional Control

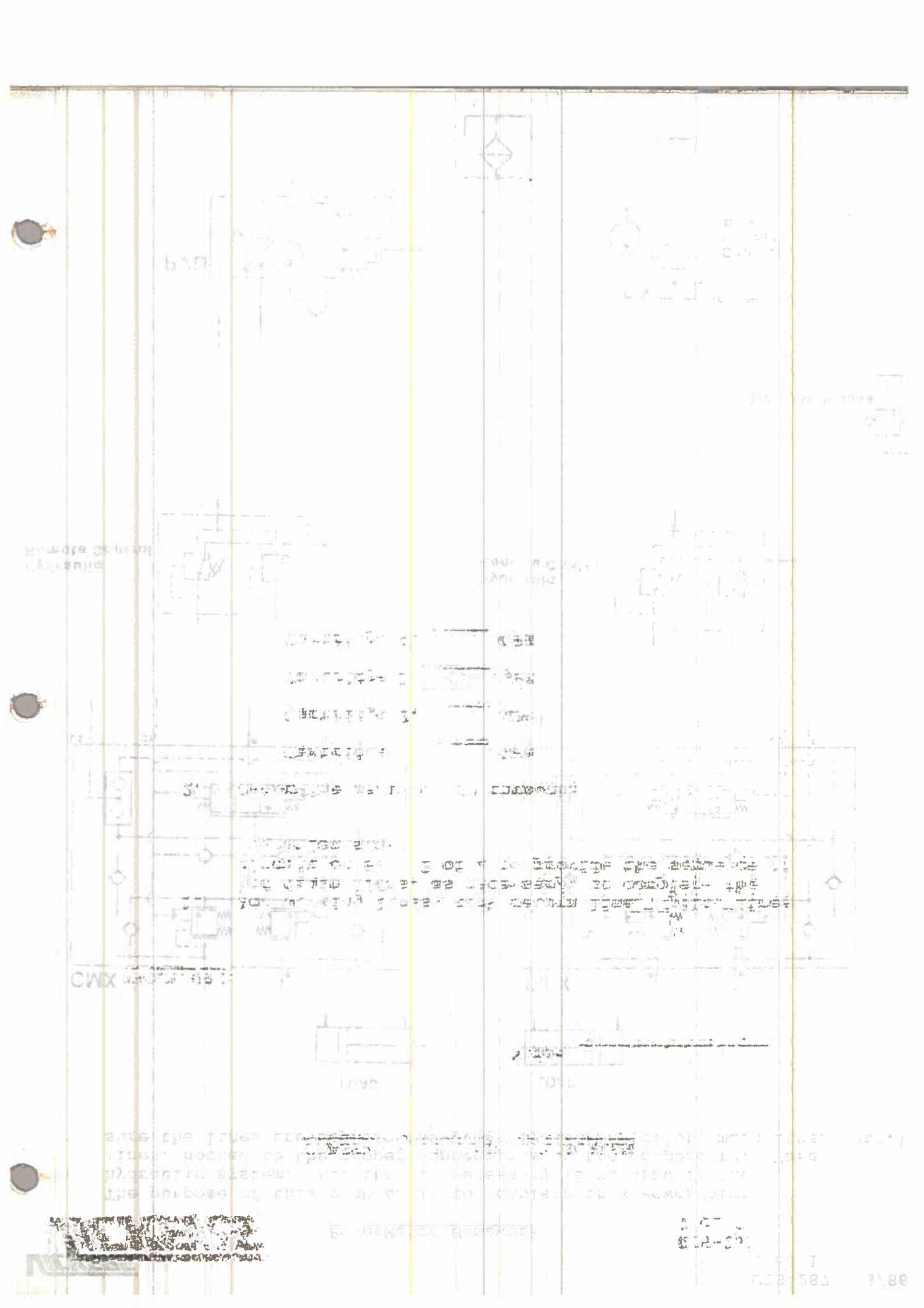
NAME _____

1. In the figure below, solenoid (b) is shown in the energized position directing pilot oil to shift the main valve spool causing the cylinder to retract. If the solenoid is de-energized before the cylinder reaches the end of its stroke, describe what will occur.



2. In the figure below, describe what will occur if solenoid (b) is energized.





CLASSROOM OR HOMEWORK PROBLEM

Name: _____

PROCEDURE:

1. Add working lines, tank return lines, pilot lines and drain lines, as necessary, to complete the circuit on Page 2 of 2 to provide the sequence of operation shown.

2. Determine maximum GPM through:

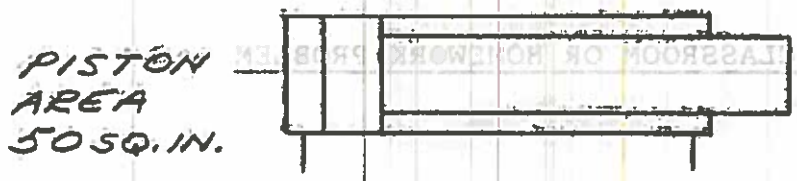
   Cartridge 1. _____ GPM

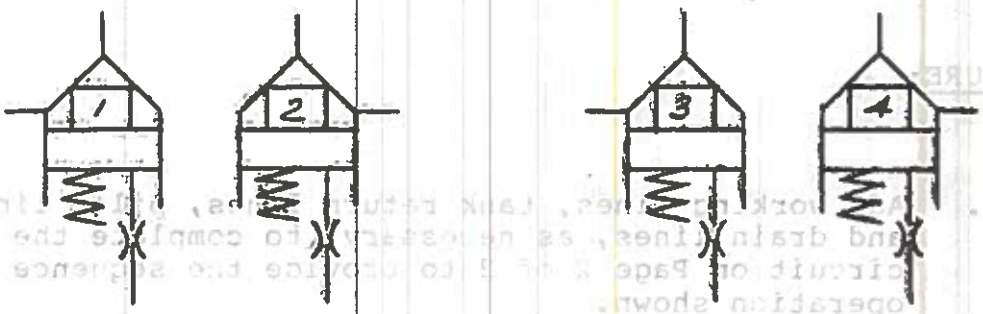
   Cartridge 2. _____ GPM

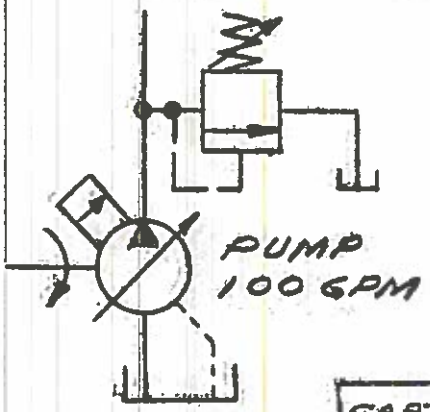
   Cartridge 3. _____ GPM

   Cartridge 4. _____ GPM

CTS-283
2 OF 2
REV. 5-19-86







SEQUENCE OF OPERATION	CARTRIDGE				SOL.	
	1	2	3	4	a	b
I. IDLE	O	C	C	O	-	-
II. REGENERATIVE ADVANCE	C	O	O	C	+	+
III. CONVENTIONAL ADVANCE	C	O	C	O	+	-
IV. RETRACT	O	C	O	C	-	+

C - CLOSED
O - OPEN